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A STUDY OF THE LESIONS IN THE VASCULAR SYSTEM IN FATAL CASES OF CHRONIC NEPHRITIC TOXÆMIA OF PREGNANCY

MALIGNANT NEPHROSCLEROSIS¹

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THE toxæmias of pregnancy present a series of problems which are of the utmost importance. These have been attacked from a variety of viewpoints including the study of the histopathological lesions, the chemical and metabolic changes, and the clinical aspects. None of these studies can be completely satisfactory without information as to etiology, and this is entirely lacking. However, material is accumulating which is adding much to the understanding of the processes. It is the purpose of this paper to present observations on the lesions in the vascular systems of those patients who have been injured by pregnancy toxæmias and who have eventually died after a typical clinical course. These lesions have not been adequately described in relation to pregnancy toxæmias but have received much attention in other conditions under the term malignant nephrosclerosis by Volhard and Fahr (1914), Fahr (1934), Schuermann and MacMahon (1933), and others. A study of the literature shows that the frequency with which this condition occurs in relation to pregnancy toxæmias has been overlooked. Descriptions of the so called obstetrical chronic nephritis also lack a realization of the similarity of the two conditions.

The material is that obtained at autopsy on patients who have died on the obstetrical service of Johns Hopkins Hospital. It does not represent in any way the total incidence of the condition since the vast majority of the women who die of chronic nephritis following a pregnancy toxæmia do not return to the obstetrical service at this time. For completeness, consideration was given to the histories of all patients who were indexed as having died of nephritis. The material from all upon whom autopsies had been done was obtained and, wherever possible the kidney, adrenal and pancreas were studied. To the usual staining procedures were added the connective tissue stain of Mallory and the elastic tissue stain of Verhoeff.

This study does not include the deaths from eclampsia. As will be seen, it does include in so far as autopsy material allowed, all other deaths in which kidney lesions were clinically suspected. Two groups of material emerged. There was, first, that group in which a pregnancy toxæmia had occurred, hypertension had persisted postpartum and after a varying period of time, uræmic death had ensued. This group constitutes the subject of the present study.

Brief consideration has also been given to

the second group studied. In these patients, we have no history of prolonged severe hypertension and the condition may be considered as acute and of short duration. These have been included for comparison and for the purpose of stressing the fact that there is an essential histological difference between the lesions of the acute toxemias of pregnancy and those which may ultimately lead to the death of the individual concerned. A difference in etiology or mechanism of production is not implied.

In 1927 a toxemia clinic was established at Johns Hopkins Hospital with the object, not only of giving special attention to those patients who show toxemias during pregnancy but also of following these patients after delivery for treatment and for the collection of data. This clinic has yielded valuable information particularly as to the ultimate prognosis for those patients upon whom a diagnosis of chronic nephritis following a pregnancy toxemia has been made. This will be considered below. It has also served to focus attention upon the end stages of the disease and is steadily producing more and more material for study of the condition.

It should be stated that the term chronic nephritis is used here in the sense employed by Stander and Peckham (1926) in their classification of the toxemias of pregnancy. This diagnosis is made during pregnancy when the blood pressure rises above 155 millimeters mercury systolic and/or 100 millimeters mercury diastolic, with or without albuminuria and in the absence of signs and symptoms of pre-eclampsia. The previous history and the blood chemistry findings, the type and degree of the urinary findings, and the physical examination with special attention to the eye grounds will temper the diagnosis. Peckham and Stout (1931) showed that one fifth of the patients so diagnosed showed no demonstrable damage at subsequent examinations. On the other hand one-fourth of those diagnosed as of the low reserve kidney or pre-eclamptic type during pregnancy and the early puerperium were shown to have residual damage later. The immediate clinical diagnosis then is a loose one and must be controlled by prolonged observation after delivery. This gives

the second set of criteria for the diagnosis of chronic nephritis. The presence of a persistent hypertension of 150 millimeters mercury systolic and/or 100 millimeters mercury diastolic and/or a persistent albuminuria postpartum (Peckham and Stout 1931) allows such a diagnosis, while the absence of any of these makes it unlikely that the original toxemia has been of the chronic nephritic type.

Such a follow up will yield surprising information. Peckham (1931) has shown that of 74 eclampsias so observed 23 per cent showed ultimate evidence of chronic nephritis. Of the toxemic patients, excluding those with pernicious vomiting and eclampsia, 40 per cent showed residual damage. Some of these latter however were known chronic nephritics before the present pregnancy so that the incidence here expressed is not a proper expression of the incidence relation. But these figures do serve to point out the frequency with which permanent damage to the woman follows the toxemias of pregnancy. It should be pointed out that this is at variance with the observations of Heynemann (1924), Fahr (1924), Zondek and co-authors (1924) and Nevermann (1927) as reported by Bell (1932).

The next step is to consider what eventually happens to these women with chronic nephritis. Stander and Peckham (1931) reported on 135 women who had a chronic nephritic toxemia of pregnancy and who had been observed on the obstetrical service of the Johns Hopkins Hospital during pregnancy one or more times over a period of from 1 to 11 years previously. They found that 46 were dead and of these 37 had died of clinical nephritis. Of those alive 26 showed no evidence of permanent cardiovascular renal damage (the one-fifth error referred to above) while 30 had evidence of a severe chronic nephritis, and 20 showed signs of moderate chronic nephritis. Of the remainder no information was obtained.

It is shown then that this sequence of events toxemia of pregnancy chronic nephritis, and ultimate early death occurs with striking frequency. A causal relation might be presumed but is not established. It would seem that a careful histological study of the steps in the process might yield valuable information.

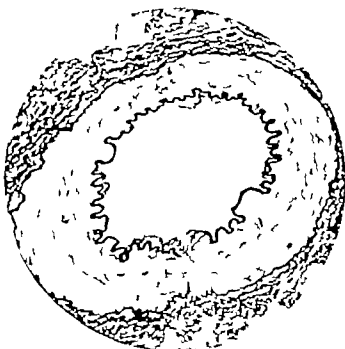


Fig 1 Interlobar artery showing vascular hypertrophy. Note particularly the thick muscular media. (Verhoeff's elastic tissue—Van Gieson connective tissue stains) $\times 88$.



Fig 2 Arcuate artery showing vascular hypertrophy. The media is thickened and well preserved. There is a connective tissue thickening of the intima and a well developed lamellar elastosis. (Verhoeff's elastic tissue—Van Gieson connective tissue stains.) $\times 88$

Until recently this was confined to a consideration of the lesions of eclampsia. The work of Zangemeister in directing attention to the tissue oedema and its extrarenal cause as a fundamental condition and of Hinselmann (1921, 1924) in the study of capillary spasm, are too well known to require comment. The work of Volhard and Fahr on the kidney gave a new impetus to the study of that organ in the toxæmias. Their division of kidney disease into nephritis, nephrosis, and sclerosis clarified the obstetrical problems. Volhard (1918) pointed out that the kidney lesions seen in the toxæmias of pregnancy and particularly in eclampsia are not primarily degenerative but show a typical ischaemia of the glomeruli with marked secondary parenchymal changes. This directed attention once more to the vascular system. Heynemann (1920, 1921) took issue with this, described the lesions of the toxæmias as a whole as degeneration in the glomerulus and the convoluted tubules and coined the term "pregnancy glomerulonephrosis" to describe it. He was careful to point out, however, that when blood appears in the urine or the systolic blood pressure goes above 165 or 175 millimeters mercury or when the blood pressure remains elevated following preg-



Fig 3 Lobular artery showing vascular hypertrophy with a connective tissue thickening of the intima, the internal elastic lamina is stretched and the outer muscular media still partially intact is narrow. Superimposed on this older process is a recent change with saturation of the intima with blood, partial thrombosis, focal disappearance of internal elastic lamina, and hemorrhage into the media and adventitia. (Hæmatoxylin and eosin.) $\times 140$



Fig 4 Lobular artery with branching afferent arteriole. There is intimal hypertrophy, connective tissue thickening of the intima, a deposition of fluid like ground substance beneath the endothelium, swelling of the endothelial cells, and collapse of the lumen. The muscular media in places is still easily recognizable. The smaller branches show occlusion of their lumina, thrombosis, and a saturation of their walls with plasma and fibrin (Hematoxylin and eosin) $\times 95$.



Fig 5 Small lobular arteries. The adventitia is thickened, the media is largely replaced by connective tissue. One of the vessels shows a fusiform swelling of the basement membrane. There is a mucous thickening of the intima, with few cells and an abundance of mucinous intercellular ground substance. The lumina are greatly narrowed. The endothelial cells are swollen. In such vessels one may trace the incorporation of endothelial cells into the underlying ground substance (Hematoxylin and eosin) $\times 95$.



Fig 6 Lobular artery showing hypertrophy. The muscle fibers of the media are large, stretched, and not easily recognizable. Internal elastic lamina stretched but intact. Lumen apparently obliterated due to great thickening of intima. In this thickened intima are concentric lamellae of cells, mucoid intercellular substance, newly formed elastic fibrils, scattered endothelial cells (Hematoxylin, eosin) $\times 95$.

nancy, the condition is likely to be a glomerulonephritis with proliferative lesions in the glomerulus as described by Volhard (1918). No attention was given by either of these authors to the vessels of the kidney other than the afferent arteriole and the capillaries of the glomerular tuft.

Many other investigators have examined and reported upon the kidney lesions of the various toxemias. Among these Bell (1932) describes a series in which pregnancy had occurred in the presence of pre-existing kidney disease. The microscopic findings are incomplete and his conclusion is that the kidneys show "typical advanced chronic glomerulonephritis." Baird and Dunn (1933) also describe 5 cases of chronic nephritic toxemia with similar conclusions. Neither has given attention to the arteriolar lesions. Russel (1930) described similar lesions in a group which she designates "toxemias of pregnancy other than eclampsia." A search of the literature has revealed no complete description of the vascular lesions of those women who have



Fig. 7. Lobular artery showing hypertrophy. The muscle fibers of the media are large, stretched, and indistinct. The internal elastic lamina is thick and granular. The intima is greatly thickened by concentric lamellae of spindle shaped cells and intercellular fibrils embedded in a mucoid ground substance which near the lumen contains plasma and fibrin. Endothelial cells swollen and indistinguishable from underlying cells in ground substance. Leucocytes within lumen. (Hematoxylin and eosin.) $\times 585$.



Fig. 8. Lobular artery with small afferent arteriole. The lobular artery is almost completely transformed into concentric lamellae of cells and intercellular fibrils embedded in a mucoid ground substance. The lumen is apparently obliterated. The endothelial cells are swollen and may be traced into the underlying ground substance. The wall of the small afferent arteriole is saturated with plasma and fibrin (Hematoxylin and eosin.) $\times 350$.

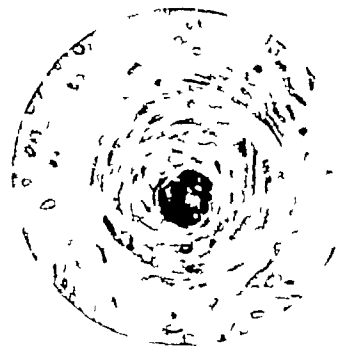


Fig. 9. Lobular artery. The muscular media is replaced by connective tissue. The intima is greatly thickened by concentric lamellae of spindle shaped cells and intercellular fibrils, embedded in a vacuolated mucoid ground substance. The lumen is obliterated by a small fibrin thrombus. (Hematoxylin and eosin.) $\times 350$.

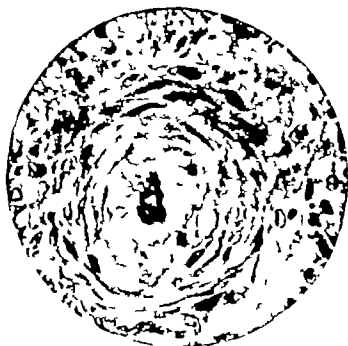


Fig. 10. Small lobular artery. Muscle fibers of media still recognizable they are hypertrophied. The thickened intima is largely composed of a mucoid ground substance in which few cells and delicate fibrils may be seen. Endothelial cells are swollen and stain intensely. Lumen collapsed and nearly obliterated. (Hematoxylin and eosin.) $\times 425$.



Fig. 10

Fig. 10. A small lobular arteriole, almost completely replaced by a tube of coagulated plasma and fibrin. The lumen is very narrow, the endothelial cells are swollen. There is beginning organization by proliferation of adventitial cells. (Hematoxylin and eosin) X 170.

Fig. 11. Small lobular artery showing a severe and fresh lesion. The lamina propria wall is split apart and saturated with plasma and blood cells and polymorphonuclear leucocytes. There are red blood cells and polymorphonuclear leucocytes within the lumen. (Hematoxylin and eosin) X 170.

Fig. 12. Afferent arteriole and glomerulus. The lumen of the afferent arteriole is distended with blood, the sub-endothelial basement membrane is fragmented and the wall is saturated with blood. There is an aneurysmal dilatation of the afferent vessel just after entering the glomerulus. There is a hemorrhage into the vessel wall and into the framework of the glomerular tuft. Some of the capillaries of the glomerulus are collapsed, others show extreme dilatation with fragmentation of the basement membrane and hemorrhage into the capsular space and proximal convoluted tubule. The overlying epithelial cells are swollen, granular and some contain hemosiderin. (Hematoxylin and eosin) X 170.

Fig. 14. Afferent arteriole and glomerulus. Both are unusually large. The wall of the arteriole is saturated with plasma. The lumen is partially occluded with a fibrin



Fig. 11.

thrombus. The same changes are seen in portions of the glomerular tuft in which blood cells, plasma, and fibrin appear beneath the endothelium of the capillaries, often obstructing the lumen. The overlying epithelial cells, and cells of the capsule show degeneration and desquamation. There are scattered polymorphonuclear leucocytes and red blood cells, together with fibrin and precipitated protein within the capsular space. (Hematoxylin and eosin) X 170.

Fig. 5. Two glomeruli with their respective afferent arterioles. The walls of the afferent arterioles are saturated with plasma, fibrin, and fragmented red blood cells. Their lumina are partially thrombosed. In the one glomerulus the capillary tuft is collapsed, in the other the capillaries are overdistended with blood, the basement membrane is stretched, and there are red blood cells within the capsular space and convoluted tubules. (Hematoxylin and eosin) X 170.

Fig. 6. Glomerulus showing aneurysmal dilatation of the afferent vessel after entering the glomerulus. The lumen of this vessel is distended with red blood cells and the wall is saturated with blood and fibrin. Many of the capillaries contain red blood cells, others are collapsed. The walls of the capillaries are thickened by a reduplication of the basement membrane and also by an increase in the ground substance beneath the endothelium. (Hematoxylin and eosin) X 170.

died a clinically nephritic death following a chronic nephritic toxemia of pregnancy.

On the other hand, Volhard and Fahr (1914) and Fahr (1934) called attention to a condition which was characterized by marked elevation of blood pressure and a quickly fatal course with uræmic death. This appeared in individuals of middle life and about equally in males and females. The histological findings in the small arteries and arterioles throughout

the body were characterized by necrotizing changes of the wall, saturation of the walls with plasma and red blood cells and proliferation of the endothelium and connective tissue of the intima described as an endarteritis which often led to apparent occlusion of the lumen. These were found scattered throughout the body but particularly in the kidney and also in the pancreas, adrenal, gastrointestinal tract and brain. The changes in



Fig. 13.



Fig. 14.



Fig. 15

(Legend on opposite page)

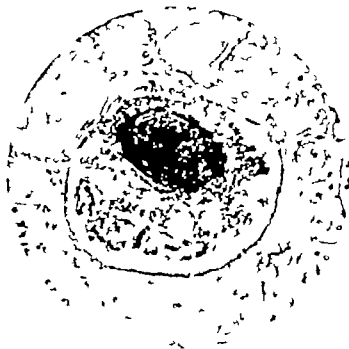


Fig. 16

the kidney involved not only the large and smaller vessels, but also the glomeruli and tubules. Unlike the lesions of diffuse glomerulonephritis which are found in all glomeruli, the changes here tend to be focal, involving single or groups of glomeruli in a degenerative and inflammatory process. The tubules present a picture in which the changes in the lining epithelium vary from slight degeneration

to necrosis and desquamation. This they described as a pathological entity under the term malignant nephrosclerosis. This work was confirmed and extended by Schuermann and MacMahon (1933) and others. Much work has been carried on in studying this condition, but the etiological relation of the toxæmias of pregnancy has not as yet been described.



Fig. 17, left, boy. Glomerulus, showing an organizing process with proliferation of endothelial cells which form a tumor-like projection growing into the dilated afferent arteriole, partially occluding the lumen. There are still rudimentary form and fragmented red blood cells within the structure of the glomerulus. The proliferating endothelial cells are separated by a newly formed delicate intercellular fibrillar reticulum. The basement membrane of the capsule is absent along one side and is often and fibrillated along the other. (Hematoxylin and eosin) $\times 64$.

Fig. 18, right, above. Glomerulus, showing a still later stage than Figure 7. At the pole of the glomerulus, proliferating endothelial cells together with their intercellular fibrillar reticulum have formed small graminous-like nodules. This represents a late stage in the organization and repair of the injured afferent vessel as seen in Figure 16. The lumen of the afferent arteriole is not completely occluded,



and the capillaries of the glomerular tuft contain a moderate amount of blood. (Hematoxylin and eosin) $\times 170$.

Fig. 19, left below. Glomerulus, greatly enlarged. Most striking is the proliferation of the epithelial cells covering the capillary tuft and capsule; they form adhesions between the tuft and the capsule and often build small gland-like structures. The capillaries of this glomerulus contain a small amount of blood and there is an increase in ground substance and scattered hemorrhages into the capillary walls. (Hematoxylin and eosin) $\times 155$.

Fig. 20, right, below. Glomerulus. Most striking is the well-developed crescent of proliferating capsular epithelial cells. The capillaries of the glomerulus contain little blood. The walls of the capillaries are thickened by an increase in subendothelial ground substance. The epithelial cells covering the capillaries are large and show droplet degeneration. (Hematoxylin and eosin) $\times 155$.

DESCRIPTION OF CASES

CASE 1 J H H U 34614 T 534. Patient aged 40 years, colored 4 full term pregnancies, 1 living child Weight 174½ pounds.

The patient was seen at age 33 years, at which time she was 7½ months pregnant. The blood pressure was 100/100, the urine contained 0.8 gram albumin (Esbach). She was admitted for study but left the hospital against advice and was delivered elsewhere of a stillborn fetus. At age of 35 years she returned in labor with a blood pressure of 250/130 and delivered spontaneously.

At age of 40 years, she returned, not pregnant, complaining of pain in the stomach swelling of the legs, and difficulty in getting the breath. Patient stated that her father had died of 'bladder trouble' and her mother of kidney trouble. Her blood pressure was 148/96, eyegrounds showed marked vascular retinitis, bilateral. The phenolsulphonphthalein test showed less than 5 per cent excretion in first and second hour. The non protein nitrogen of the blood was 20.8 milligrams per cent and the uric acid 9.8 milligrams per cent. The urine contained one plus albumen, 1 to 3 white blood cells per high power field and no red blood cells. The blood pressure rose after admission to 162/160 millimeters mercury and the patient died. Clinical diagnosis chronic nephritis with terminal uræmia.

Autopsy showed generalized arteriosclerosis arteriosclerotic nephritis necrosis in the pancreas cardiac hypertrophy and fatty heart chronic passive congestion of the lungs and lobular pneumonia.

Microscopic examination of kidney The normal architecture of the kidney is almost completely lost. The cortex and medulla are poorly demarcated and the surface is finely granular. There is a chronic process involving the vessels, glomeruli, and tubules which has led to considerable and diffuse sclerosis of the cortex. Superimposed on this is an acute destructive lesion of the vessels and glomeruli with hæmorrhage throughout the walls of the small vessels, and capillary dilatation within the glomeruli. There are in places, extensive hæmorrhages into the capsular spaces. These histological changes constitute a classical example of well advanced malignant nephrosclerosis. A description of the finer details of this case will serve as a standard for the others of its class to be described.

Vessels The entire arterial tree shows marked hypertrophy of the vessel wall (Fig. 1). In the interlobar, arcuate and larger branches of the lobular arteries the media is thickened and well preserved. There is a connective tissue thickening of the adventitia and of the intima. In the latter is seen a well developed lamellar elastosis (Fig. 2).

The smaller lobular arteries and the afferent vessels to the glomeruli show replacement of their muscular media by connective tissue. Three important changes in the intima are also seen. The most common is the endarteritis obliterans in which the thickened intima appears as concentric rings of cells and intercellular substance which frequently produces an

apparent occlusion of the lumen (Figs. 4, 5, 6, 7, 8, 9). Another lesion is the presence of a variable quantity of a poorly differentiated ground substance beneath the endothelium (Fig. 10). Finally, and most striking there are fresh hæmorrhages throughout the vessel walls (Figs. 11, 12).

Glomeruli More than 90 per cent of the glomeruli are still moderately well preserved. They are larger than normal slightly more cellular, decidedly anæmic and show an increase in the basement membrane and subendothelial ground substance. Superimposed on these changes are the fresh lesions so characteristic in the glomeruli of malignant nephrosclerosis. There are aneurismal dilatation of the capillaries, rupture of the basement membrane, and extensive hæmorrhages into the capsular space and tubules (Figs. 13, 14, 15, 16). In glomeruli in which this lesion is somewhat older are seen proliferation of both endothelial and epithelial cells (Figs. 17, 18, 19, 20) and in still older lesions, an organizing process with sclerosis and adhesions between the tuft and the capsule.

A few scattered glomeruli are acellular and show hyaline transformation. The epithelial cells covering the glomerular tufts are frequently seen to be swollen with hyaline droplet degeneration.

Tubules The changes in the tubules are much more marked than those in the glomeruli. Those still recognizable as well differentiated proximal convoluted tubules are only occasionally seen and then usually in small islands at the periphery of the cortex. The great majority of the tubules are small, atrophic and collapsed. Many have disappeared entirely. The epithelial cells lining the tubules show degenerative changes and desquamation. Within the lumina are red blood cells, polymorphonuclear leucocytes, cellular debris, and precipitated protein.

Stroma There is a diffuse increase in the connective tissue stroma which occasionally shows a focal lymphocytic infiltration.

Adrenal and pancreas The changes in both large and small vessels of the adrenal and pancreas are similar to those already described in the kidney, although the lesions are less striking. The pancreas shows, in addition, areas of pancreatic necrosis.

The most striking changes in the kidney are those of the vascular tree. There is the vascular hypertrophy, the intimal elastosis, the proliferating endarteritis and the hæmorrhage and necrosis of the walls. The tubules show widespread atrophy and disappearance, and present a striking contrast to the large number of fairly well preserved glomeruli. The latter show the increase in size and anæmia so commonly seen in malignant nephrosclerosis, also the acute lesions—hæmorrhage into the tuft and the walls of the capillaries of the tuft, and into the capsular space. These lesions are characteristic of malignant nephrosclerosis.

CASE 2 J H H U 30132 T 542 Patient aged 24 years, colored, has had 1 pregnancy at term, 1 abortion, 1 living child. At age of 17 years she had a soft chancre. Physical examination at that time revealed no other abnormality. Wassermann was negative. At age of 21 years she was admitted at 8½ to 9 months pregnant. Her mother died of "jaundice" her father of heart trouble. Blood pressure was 120/140. Urine showed an occasional granular cast, albumin, a faint trace and many white blood cells. Blood non-protein nitrogen was normal. Uric acid was 5.1 milligram per cent. Eye-grounds showed "retinal edema." The blood pressure fell quickly after delivery and at discharge was 115/90.

At age of 22 years, patient returned 4½ to 5 months pregnant. Blood pressure was 120/130. Urine was negative for albumin. Eye-grounds showed retinal edema. Urea clearance was 74 per cent. On observation with bed rest the blood pressure fell to 124/88 and patient was discharged. She was readmitted one month later. Blood pressure was then 170/120, eye-grounds were normal, the urine negative. Hysterotomy and tubal sterilization were done. Six weeks after operation, blood pressure was 160/100, urine negative.

Six months after operation, patient was readmitted for study. Blood pressure on admission 193/155 fell to 160/105 on discharge. Examination showed blood chemistry and urine normal. Eye-grounds showed retinal edema.

One year after operation, blood pressure was 175/180 and the patient complained of "dizzy spells." Interval blood pressures were about of this level.

The patient was readmitted at age of 24 years, complaining of headaches, dyspnea, and blurring of vision. Blood pressure was 200/180, urine albumin faint trace, eye-grounds, renal retinitis and arteriosclerosis. Phenolsulphonphthalein test 2 hour excretion was 35 per cent. Menses at test, fixed specific gravity, urine occasional red blood cell and white blood cell.

She was discharged but readmitted shortly thereafter with a blood pressure of 240/160, complaining of dyspnea and showing evidence of cardiac decompensation. Eye-grounds showed retinal hemorrhages. Urine contained many white blood cells, occasional red blood cells and casts. The patient died on the fourth day. Clinical diagnosis chronic cardiovascular renal disease.

Autopsy report was not available.

Microscopic examination of kidney. Here, too the architecture of the cortex is greatly altered as a result of the atrophy and disappearance of the tubules in some areas and their dilatation and elongation in others. The vessels show the same lesions as in Case 1 but these are more frequently seen and more severe. One of the striking features is that the few remaining well differentiated proximal convoluted tubules are localized in areas at the very periphery of the cortex and resemble in this regard, the zones of healthy tissue seen in Case 5.

Vessels. The lesions in the vascular tree are as described in the standard Case 1. Hemorrhage and saturation with plasma of the walls of the smaller vessels is commonly seen (Figs. 11, 12). In the lobular arteries, these fresh lesions are largely limited to the intima and the elastic lamina appears stretched but unbroken. These changes may frequently be traced to the corresponding glomerulus which shows in turn a similar change (Figs. 13, 14, 15, 16). There are older lesions in which the fibrin in the wall of the small vessels shows organization, and granuloma-like formations are seen along the afferent arterioles (Figs. 17, 18). The endothelium of these small vessels is swollen and shows proliferation. Fibrin thrombi occasionally obstruct the lumina.

Glomeruli. The glomerular lesions are typical of those seen in malignant nephrosclerosis. The proportion of glomeruli in a state of reasonable preservation to those which have been destroyed and have become hyaline is as in Case 1. The same changes in the relatively intact glomeruli are seen. In some of the afferent arterioles there is seen what appears to be a very recent aneurysmal dilatation where the vessel enters the glomerulus (Fig. 16). There is hemorrhage into the walls of these vessels and into the capsular space while the capillaries of the tuft are dilated (Figs. 13, 14, 15).

Tubules and stroma. These show the same changes as those described in Case 1.

Pancreas and adrenal. The arterioles of both organs show hypertrophy of the media. The small vessels show hyaline transformation of their walls. The arterioles of the pancreas show, in addition, plasma beneath the endothelium although this is not frequently found.

The lesions in this case are similar in every respect to those described in the standard case. The histological findings suggest that the process has been the most severe of the group.

CASE 3 J H H U 18867 T 535. Patient aged 36 years, colored, has had 5 term pregnancies, 3 abortions, 5 living children. At age of 31 years she was observed throughout a pregnancy. The systolic blood pressure reached 195 millimeters mercury and the diastolic 106 millimeters mercury. The urine was negative throughout. The weight 151 pounds. At age of 32 years she was observed during another pregnancy. Highest systolic blood pressure was 150 millimeters mercury, highest diastolic 112 millimeters mercury. Urine was negative throughout. The weight reached 16 pounds. At the age of 34 years she again became pregnant and was admitted at the sixth month. Blood pressure was 214/110, urine contained two plus albumin, weight was 170 pounds. After admission the blood pressure rose to 236/174. Phenolsulphonphthalein test showed 32 per cent in first hour, 13 per cent second hour. "Marked retinal arteriosclerosis and arteriosclerotic retinitis." There was edema of the extremities, urine contained albumin 2-3 plus, fine granular casts and red blood cells.

The patient aborted spontaneously. She was seen a year later, not pregnant, blood pressure 210/150, urine, albumin 2 plus. One year after this a blood pressure of 224/170 was recorded.

At age of 36 she again became pregnant and was admitted at 3 to 4 months. Blood pressure 200/140. Phenolsulphonphthalein test, 35 per cent excreted in first hour, 20 per cent second hour. Blood non-protein nitrogen was normal. Urine showed albumin 3 plus with fine granular casts and red blood cells. The patient was sterilized by hysterectomy. Six weeks later blood pressure was 200/150 urine albumin 1 plus. Four weeks later blood pressure was 210/170.

Eight months post abortum the patient was admitted, not pregnant, complaining of headaches and bloody urine. Blood pressure was 258/198 phenolsulphonphthalein test, 8 per cent in 2 hours. Non-protein nitrogen of blood 85.6 milligrams per cent. The 24 hour urine volume varied between 400 and 600 cubic centimeters. The patient died. Clinical diagnosis chronic nephritis.

Autopsy showed chronic arteriolosclerotic nephritis cardiac hypertrophy with myocardial scarring lobular pneumonia, slight perivascular mononuclear infiltration in the medulla slight arteriosclerosis of aorta adenomata of thyroid hypophyseal duct cyst with atrophic changes in the hypophysis.

Microscopic examination of kidney. The kidney architecture is moderately well preserved although there is a diffuse increase in the connective tissue throughout the cortex and fine granulation of the surface. The vessel changes are characteristic of malignant nephrosclerosis.

Vessels. Lesions are similar in all respects to the standard Case 1.

Glomeruli. Most glomeruli are fairly well preserved. The most striking lesions are the recent degenerative and inflammatory changes. These present an accumulation of ground substance between the endothelium and the basement membrane producing apparent complete occlusion of the lumen of the capillaries. In these glomeruli the endothelial cells are increased in number and the overlying epithelial cells show marked swelling droplet degeneration, and proliferation. These cells are found continuous with those of the capsular wall (Fig. 19). There are no aneurysmal dilatations although occasionally red blood cells are found within the capsular space.

Tubules and stroma. The lesions here are as described in Case 1 although in this case a greater number of tubules retain their differentiation.

Pancreas. There is hypertrophy of the media of the larger arteries sclerosis and hemorrhage into the wall are seen in the smaller arterioles. In general the lesions are similar to those seen in the vessels of the kidney although of lesser degree.

Again the most striking lesion is that of the arterial tree of the kidney. The changes in the glomeruli and tubules are not far advanced

and are largely degenerative. The changes are typical of those described in malignant nephrosclerosis, although the lesions in this case are not so advanced as in Cases 1 and 2.

CASE 4. J.H.H.U. 29163 T 539. Patient aged 37 years, colored had had 4 pregnancies at term 2 abortions, 4 living children. Her weight was 119 pounds. At age of 35 years, not pregnant, blood pressure was 288/140 Wassermann was negative. Family history was negative. At age of 36 years she was admitted to hospital 5 months pregnant. Blood pressure was 230/160 moderate cardiac hypertrophy no abnormal symptoms. Eyegrounds normal save for attenuation of arteries. Phenolsulphonphthalein test showed 15 per cent first hour 25 per cent second hour. Urine revealed a trace of albumin otherwise negative. Therapeutic abortion and sterilization were done. On discharge, blood pressure was 160/115 urine, negative.

The patient was observed frequently following this. The blood pressure continued at about the level of 230/150 and the urine remained negative. She complained of occasional headaches.

At age of 37 years she was admitted not pregnant. Blood pressure was 240/150. Eyegrounds showed moderate arteriolosclerosis without hemorrhages or exudates. Blood non-protein nitrogen was 57.8 milligrams per cent. Blood uric acid 7.2 milligrams per cent. Urea clearance test 7.5 per cent. Urine showed occasional white blood cells and granular casts albumin 3.5 grams (Esbach). The patient died. Clinical diagnosis chronic nephritis.

Autopsy showed chronic nephritis with hemorrhages cardiac hypertrophy, subendocardial hemorrhages fat in myocardium cystitis lobular pneumonia.

Microscopic examination of kidney. The lesions in the component parts of the kidney are very similar to those in Case 3. The lesions are typical of those described as malignant nephrosclerosis but the severity of the lesions in this case is the least of those described in this series.

The vessels present the same picture as that in the standard Case 1. Fewer glomeruli are anemic and fewer have undergone hyaline degeneration. There is no marked capsular change, and adhesions are rare. The majority of the tubules are still well differentiated although granular and droplet degeneration are common.

The striking lesion, again, is in the arterial tree of the kidney and both chronic and fresh lesions may be recognized. The tubules in general are moderately well preserved. Only kidney tissue was available for study.

Two cases showed variations from those described as typical of malignant nephrosclerosis. The first of these Case 5, shows an exaggeration of the usual lesions with an added

infarction of the cortex. It presents the most severe form of the lesions seen in this series. A description of this case is followed by that of Case 6 which may be placed at the opposite end of the list. It represents a transitional stage between malignant nephrosclerosis and the lesions of what has been described as benign nephrosclerosis. The histological findings are similar to those of malignant nephrosclerosis but are of a mild degree in comparison with the typical picture as described above.

CASE 5. J.H.H. 51 T 533. Patient aged 35 years, colored, had had 8 full term pregnancies, premature labors, 1 abortion, 6 living children. There are available records of 4 previous pregnancies. At the age of 20 and 26 two pregnancies were normal. At 32 years a pregnancy was complicated by a blood pressure of 170 millimeters mercury as highest systolic and 95 millimeters mercury as highest diastolic. There was a moderately severe preclampsia of short duration but the pregnancy went to term and ended spontaneously. At 39 years there was another term pregnancy with highest systolic blood pressure of 145 millimeters mercury and highest diastolic of 85 millimeters mercury. The urine was negative throughout. The Wassermann was also negative. The patient said that her mother had died of dropsy.

The present pregnancy ended in the spontaneous abortion of a 5 to 6 month fetus elsewhere. The patient had suffered throughout pregnancy from "dim vision and a sense of weakness." Interference with vision became more marked postpartum and the patient was admitted. The findings on admission were blood pressure 166/110, temperature 98.6 degrees F, urine albumin 4 plus, specific gravity 1.012, no casts or red blood cells. External ocular muscle movements were poorly performed. The following day the patient showed twitching of the right arm and leg. The blood pressure had risen to 170/144, hemoglobin 35 per cent, and there was a leucocytosis of 20,20. Phenolsulphonphthalein test showed no excretion in either the first or second hour and the non-protein nitrogen of the blood was 162.5 milligrams per cent. On successive days the non-protein nitrogen of the blood rose to 240 and 35 milligrams per cent. The Wassermann reaction was negative. The patient died. Clinical diagnosis chronic nephritis with anemia.

Autopsy showed "puerperal uterus with infection chronic diffuse nephritis with necrosis and thrombosis of the arterioles. Infarctions of the kidney multiple necroses of the pancreas hyperplastic bone marrow alteration of the spleen oedema of the lungs with slight lobular pneumonia."

Microscopic examination of kidney. The normal architecture of the kidney is greatly distorted. The cortex and medulla are not sharply demarcated and the cortex lacks an orderly arrangement. The sur-

face is pitted. There are two outstanding lesions. The first and more spectacular is the presence of recent scattered infarcts in the cortex. The other is a more chronic process with sclerosis of the medium sized and small vessels apparent obliteration of the lumina of these vessels, and widespread atrophy of the cortex with streaks of fibrosis of its stroma. These areas of fibrosis frequently present a triangular outline with the base at the peripheral portion of the cortex. As a result of these lesions there is very little well preserved cortical parenchyma.

Arteries. The interlobular arcuate and lobular arteries are all of unusually large diameter. The media in the larger of these is not only thickened but well preserved. The adventitia and intima are also thickened with reduplication of the internal elastic lamina of the latter. In spite of this increase in the thickness of the walls of the larger arteries the lumina are still larger than those of the corresponding vessels of the normal kidney.

The changes in the smaller vessels are similar to those described in the typical cases of malignant nephrosclerosis. Similar changes are seen even in some of the larger lobular arteries (Fig. 3). Fibrous thrombi are frequently seen and the replacement of the muscular media by connective tissue is marked. The smaller vessels are unusually tortuous. The saturation of the vessel walls is also exaggerated in degree and frequency. Plasma may be seen in all layers, and red blood cells and occasional polymorphonuclear leucocytes are found within the walls and may even be traced into the surrounding stroma. This is often associated with thrombosis of the lumen of the vessel.

Glomeruli. The glomerular changes are similar to those described with the typical cases except that they tend here to be obscured by the presence of fresh areas of ischemic necrosis.

Tubules. These also present the changes described as typical, with the additional factor as in the glomeruli. Many are filled with red blood cells, broken-down, desquamated cells and hyaline and granular casts.

Stroma. The older lesions are characterized by an increase in connective tissue and an infiltration with lymphocytes. The fresh lesions show oedema and hemorrhage.

Interlobular capillaries. The interlobular capillaries and veins are moderately distended but no histological change can be recognized.

Basement membrane. Due to the marked increase in subendothelial ground substance and the secondary organization, the basement membrane of the small arteriole is often difficult to trace. Occasionally it appears to be interrupted and bathed in plasma. In the glomerular tuft it is often wrinkled, thickened, and reduplicated.

Adrenal. The small arteries in the capsule show only hypertrophy of the media whereas in the small arterioles in the medullary portion there is hyaline swelling of the basement membrane without necrotizing arteriolitis such as is seen in the kidney.

The lesions seen here are an exaggeration of those described in the typical case. The chief lesion is that of the arterial tree in the kidney. The vascular hypertrophy, arteriosclerosis, and arterionecrosis are characteristic of malignant nephrosclerosis. This necrosis is so extensive and so frequently associated with thrombosis that it is not surprising to find many areas of ischemic necrosis of the cortex. There is then a chronic process involving the vessels glomeruli and tubules. Superimposed upon this, is recent vascular damage with necrosis of the vessel walls thrombosis and infarct formation.

This case is similar to a group described by Von Zalka (1932-1933) under the term "symmetrical cortical necrosis of the kidney." His cases were more advanced and the necrosis more widely spread. They showed either a massive necrosis or multiple infarcts of the cortex but never with involvement of the medulla. He described hyalinization of the lobular arteries, afferent arterioles, and glomeruli with fibrous thrombi in the lumen. In his own case he speaks specifically of vascular necrosis. Altogether the condition which he describes has a marked resemblance to that in the present case, although in his opinion he was not dealing with malignant nephrosclerosis.

What is equally important from the point of view of the present discussion is that he recognized the relation of "cortical necrosis" to pregnancy. He states that of 37 cases collected from the literature 31 were possibly related to pregnancy. Three, however, occurred in males and three more were not related to pregnancy. This is the closest approach to a recognition of the relation between the vascular changes described in this paper and the toxæmias of pregnancy which a search of the literature has brought to light.

CASE 6 J.H.H.U. 8662 T 531 Patient aged 29 years, colored, 6 previous pregnancies, 1 abortion and 2 living children. The first child was stillborn. The second and third are alive and well. The last three pregnancies produced stillborn children and in the last of these pregnancies the patient is said to have had convulsions. When first seen there was a pregnancy of 2½ to 3 months' duration. The heart was enlarged to clinical examination, the blood pressure 208 millimeters mercury systolic and 120 milli-

mmeters mercury diastolic. The weight was 218 pounds. The urine contained a moderate amount of albumin. The patient was admitted 2 days later when the blood pressure was found to be 256/140 the urine contained albumin occasional leucocytes, and some cellular casts. Specific gravity was 1.011. Mosenthal test showed a fixation of specific gravity of 0.010 but a varied quantity and a large night volume. Blood non protein nitrogen was 42.8 milligrams per cent. A hysterectomy was done. Three days after operation the non protein nitrogen of the blood had risen to 120 milligrams per cent and some granular casts and some red blood cells appeared in the urine. The patient died on the eighth day after operation. Clinical diagnosis peritonitis chronic nephritis with uræmia.

Autopsy showed suppuration of the abdominal incision, purulent pelvic peritonitis, early generalized peritonitis, chronic nephritis and moderate arteriosclerosis.

Microscopic examination of kidney. There is considerable change from the normal architecture of the cortex, with some reconstruction. The surface is irregular and there is moderate scarring in the form of irregularly interlacing paths of connective tissue. The most striking lesion is seen within the arterial tree. This shows a vascular hypertrophy and a sclerosis of the small arterioles. The interlobar the arcuate and the first portions of the lobular arteries show a dilatation of their lumina, a thickening of the muscular media and, here and there a reduplication of the internal elastic lamina. The distant portions of the lobular arteries and the afferent arterioles to the glomeruli show in contrast a rather striking group of changes. These vessels are tortuous, the muscular media is replaced by connective tissue, and the subendothelial ground substance is increased to such an extent as to cause in places apparent complete occlusion of the lumen. Less commonly, small granuloma like formations are seen along the vessels where they approach the glomeruli.

Most of the glomeruli are moderately increased in size and show a slight increase in the number of cells. The basement membrane itself is unchanged but the overlying epithelial cells are swollen and show hyaline droplet degeneration. The epithelium lining the capsule is also swollen and the cytoplasm shows similar regressive changes. The basement membrane of the capsule is unchanged. A relatively small number of glomeruli, in large measure confined to the areas of cortical scarring, are small, contracted and acellular and show complete hyaline transformation. Occasional adhesions between the glomerular tuft and the capsule are seen.

There remain a moderate number of easily recognizable tubules appearing usually in the form of islands bordered by tracts of scar tissue. The lumina are dilated and contain little precipitated protein. The lining epithelial cells are cuboidal with indistinct cell boundaries. The cytoplasm shows both granular and droplet degeneration. The basement membrane is unchanged. In contrast to these are

the changes seen in the tubules in the areas of sclerosis. These are small collapsed and their narrowed lumina contain minute hyaline casts. The basement membrane of these is thickened, wrinkled reduplicated, and there is occasionally an acellular ground substance between these double layers of basement membrane. In the lumina of some of the collecting tubules are granular deposits of haemoglobin.

In the areas of tubular atrophy there is an increase in connective tissue. This is infiltrated with lymphocytes and frequently shows well developed lymphoid tissue in which reticulum is clearly recognizable.

Pancreas and adrenal. The large and small arteries of the adrenal and pancreas show much the same changes as those described in the kidney. There are hypertrophy of the media of the larger vessels and intimal sclerosis with occlusion of the smaller arteries. The larger vessels show enlargement of their transverse diameter. The smaller show hyaline degeneration of the entire wall but neither necrosis nor haemorrhage. The lesions here may be described as those of arteriosclerosis.

The type of the vascular change is characteristic of neither benign nephrosclerosis with its hyaline swelling of the basement membrane nor of malignant nephrosclerosis with its interruption of the basement membrane and saturation of the wall with blood and plasma. It apparently represents a transitional stage. The tracts of sclerosis within the cortex correspond to the distribution of the more severe vascular lesions. The degenerative changes in the epithelium of the glomeruli and tubules are apparently recent and may be considered as a mild glomerulo-tubulo-nephrosis. This is in contrast to the older vascular lesions. The patient died with peritonitis presumably before the lesions of malignant nephrosclerosis had had time for complete development.

These cases have a number of features in common. The condition occurs in relatively young women usually between 30 and 40 years of age. All have become pregnant in the presence of hypertensive disease which has been adversely affected by the pregnancy. In many the original hypertensive disease appeared during the course of a toxæmia of pregnancy. After a varying period of time during which hypertension was the only feature common to all there was a sudden appearance of other symptoms referable to both the cardiovascular and urinary systems and the patients quickly thereafter died. Death in all cases was shown to be associated with uræmia.

Pregnancy occurring in the presence of a hypertension or of a chronic nephritis following a pregnancy toxæmia seems to play an important rôle in the production of the acute lesions of malignant nephrosclerosis. The degree of the interval hypertension and its duration are also determining factors. It must be stressed that all of these had had a hypertension of some duration. As will be seen later none of the cases in which death occurred during a toxæmia with hypertension for the first time showed the vascular lesions within the kidney of malignant nephrosclerosis, although in patients dying with eclampsia vascular lesions may be found within the liver identical with the acute lesions of malignant nephrosclerosis.

The microscopical examination shows the most striking lesions to be in the vascular system. These are best seen in the kidney but may also be recognized in the vessels of other organs. They show clearly a chronic condition manifested by hypertrophy of the larger and smaller arteries of the vascular bed. There is an hypertrophy of the muscular media and thickening of the adventitia. The total diameter of an artery and that of the lumen is greatly enlarged. Superimposed upon this are other lesions in the small arteries and arterioles and in the glomeruli tubules and stroma. These are characterized by

1. Thickening and hypertrophy of the intima of the arterioles with frequent apparent occlusion of the lumina (Figs. 4 5 6 7 8 9 10)

2. Saturation of the wall of the smaller vessels with blood plasma and red blood cells (Figs. 11 12)

3. Damage to scattered groups of glomeruli. These changes include aneurysmal dilatation of the walls of the afferent arterioles after they have entered the glomerulus, saturation of their walls with plasma and red blood cells, and haemorrhage into the glomerular capsule and proximal portions of the tubules. The finer histological changes have been described above (Figs. 13 14 15 16)

4. Destruction of the tubules and increase in the connective tissue stroma of the cortex. Small islands of dilated tubules remain at the periphery of the cortex

These are the lesions described as those of malignant nephrosclerosis. It is significant that every patient who fell into this clinical group showed the same histological picture. The question naturally arises as to whether or not all patients who have residual damage in the form of obstetrical chronic nephritis following a pregnancy toxæmia and who later die with clinical symptoms of uræmia will show the same clinical and histological picture. This cannot be answered by the present study. It should be pointed out, however, that the cases described above together with those which follow, make up all of the material which it was possible to obtain from the obstetrical service records of Johns Hopkins Hospital. The chance of sampling error is inherent in the study of such small groups but no other element of choice has interfered.

A further group of 5 cases died with a clinical diagnosis of nephritis. It will be seen at once that these differ from the malignant nephrosclerosis group since in none of them is there a history of hypertension before the present pregnancy.

CASE 7 J H H U 13203 T 540 Patient was 27 years of age, white and had had 2 term pregnancies with no living children. At 23 years of age a pregnancy was observed during which blood pressures of 110/86 and 122/92 were recorded. On admission at term, the urine contained albumin 2 plus and a few hyaline casts.

At 27 years of age patient was seen when 3 to 4 months pregnant. Blood pressure was 148/100. The urine showed a trace of albumin. She was admitted for study. The eyegrounds showed moderate retinal oedema, moderate arteriosclerosis. Urea clearance was 86 per cent. Highest blood pressure was 162/115. Blood chemistry analysis revealed normal findings. The blood pressure fell and she was discharged. The blood Wassermann was positive but we have no record of treatment. She was readmitted 2 months later complaining of dizziness. The blood pressure ranged about 150/100, the urine was negative, the weight 104½-109 pounds. There developed oedema generalized and in the lungs, dyspnoea and orthopnoea. The patient died, undelivered, 2 months after admission, with a diagnosis of chronic nephritis, arteriosclerosis, and cardiac decompensation.

Autopsy report showed "heart hypertrophied with hypertrophic musculature and old scars, arterioles reveal hyaline changes in kidney and pancreas intracapillary and glomerular changes in the kidney lungs, chronic passive congestion liver, slight catarrhal atrophy cells beneath capsule of

liver and in lung capillaries which closely resemble chorionic cells, liver patchy areas of dilated sinusoids surround areas in which the liver cell capillaries show what appear to be fibrin thrombi. It resembles the liver of eclampsia but the lesions are mild and focal.

Microscopic examination of kidney The normal architecture of the kidney is well preserved. The one striking pathological finding is a degenerative change in the epithelium of the glomerulus and tubules. These cells are remarkably swollen and granular. The lumina are almost obliterated, although precipitated albumin and hæmoglobin casts may be seen. The vessels and stroma show no pathological change.

Pancreas and adrenal The vessels in these organs show no lesions.

The findings here are those of glomerulotubulo-nephrosis and the histological lesions are similar to those of the eclamptic nephrosis.

CASE 8 J H H U 40316 T 536 This woman aged 33 years, colored, had had 4 term pregnancies, 4 living children. All of these were delivered elsewhere and there were no available observations until the patient was admitted about 8 months pregnant complaining of swelling of the hands and feet and blurring of vision of 3 weeks duration. Blood pressure was 230/160. Urine albumin 1.5 grams (Esbach) showed numerous red blood cells, white blood cells, and occasional fine granular casts. The eyegrounds showed advanced renal retinitis with moderate arteriosclerotic changes and some neuroretinitis. Blood non protein nitrogen was 41 milligrams per cent. Blood uric acid was 8 milligrams per cent. A caesarean section was done. Blood non protein nitrogen rose to 57.8 milligrams per cent and uric acid to 11.4 milligrams per cent. The patient died on the second day after operation. Clinical diagnosis chronic nephritis.

Autopsy showed "flabby kidneys containing much fat, old scars and cyst in right kidney, dilated right ureter containing pus, hæmorrhage in adrenal, myocardial hypertrophy hæmorrhages beneath the endocardium.

Microscopic examination of kidney The normal architecture is well preserved. There is marked swelling of the tubular epithelium with granulation of its cytoplasm. The glomerular capillaries contain blood. The epithelium covering the tuft is slightly swollen. The vessels and stroma are unchanged.

Pancreas and adrenal Both large and small vessels show no pathological findings.

The histological diagnosis is acute tubular nephrosis without vascular change.

CASE 9. J H H U 12058 T 543 This woman aged 39 years, white, had had 4 term pregnancies, 1 abortion, 4 living children. All pregnancies were observed elsewhere. When first seen the patient

was at term, blood pressure 220/140. Urinalysis showed albumin 4 grams (Esbach). She was admitted at once and labor induced by means of a bag. Delivery was accomplished by version and extraction under chloroform anesthesia and was followed by a postpartum hemorrhage of 1200 cubic centimeters with some evidence of shock. The patient died on the same day. Clinical diagnosis: pre-eclamptic toxemia, postpartum hemorrhage and shock.

Autopsy showed history of manual delivery hemorrhage and shock, postpartum uterus containing blood clot, bilateral tears of the lower uterine segment and cervix, chronic nephritis, petechial hemorrhages of heart and skin of lower extremities, old mitral endocarditis, focal necrosis of liver.

Microscopic examination of kidney The normal architecture is well preserved. The important pathological lesion is degeneration of the tubules with swelling of the epithelium and narrowing of the lumen. In an occasional tubule the cells show necrosis and calcification. The glomeruli show little change and the vessels and stroma show none.

Pancreas and adrenal These show little change although there is enough hyaline transformation of the arteriolar walls of the pancreas to allow a diagnosis of slight arteriosclerosis.

The changes here are those of a tubular nephrosis in the acute stage. The arteriosclerosis in the pancreas is so slight as to be negligible.

CASE 10 JHHU 7588 T 538 This patient, aged 15 years, colored, had had no previous pregnancies. She was admitted 7 months pregnant. There was a history of occasional hemoptysis. A right-sided pyelitis was found with pyuria. The urine contained staphylococci but no tubercle bacilli. Temperature remained normal throughout. The urine contained many white blood cells, a few red blood cells, and albumin 3 plus. No blood pressure readings were taken. Spontaneous labor yielded a stillborn premature fetus. The placenta was diagnosed as syphilitic. The patient died. Clinical details are lacking.

An autopsy report on this patient was not available.

Microscopic examination of kidney The normal architecture of the kidney is slightly distorted through an irregularity in the arrangement of the tubules. These show degeneration but also regeneration in areas where cells have been destroyed. Within the lumina of the tubules may be seen red blood cells, polymorphonuclear leucocytes, fibrin and precipitated protein, with scattered desquamated epithelial cells. The surrounding stroma in these areas of regeneration is slightly increased and edematous and shows a fairly rich infiltration with inflammatory cells. Neither vessels nor glomeruli show significant changes.

Pancreas and adrenal The arteries and arterioles show no pathological changes.

This case shows the characteristics of a tubular nephritis. There are no vascular changes.

CASE 11 JHHU 5911 T 541 Patient, aged 40 years, had had 2 abortions. When first seen, she was 8 months pregnant. The urine contained 3 grams of albumin (Esbach), specific gravity 1.018-1.020, moderate number of granular casts. Hemoglobin was 42 per cent. Blood pressure was 170 millimeters mercury systolic. A placenta previa was diagnosed and delivery by cesarean section at term under chloroform anesthesia was carried out. The patient died on the sixth day after operation. Clinical details are lacking.

Autopsy showed "acute endometritis, acute diphtheritic colitis, hemoperitoneum, fatty degeneration of the liver, chronic diffuse nephritis, chronic adhesive pleurisy, perihepatitis and perisplenitis."

Microscopic examination of kidney The normal architecture of the kidney is preserved. There is granular degeneration of the epithelium of the tubules. They are dilated and contain large quantities of precipitated protein and casts. The glomeruli show some swelling of the epithelium. There is muscular hypertrophy of the vessels which is most marked in the larger stems. The stroma is essentially unchanged although there are minute foci of sclerosis and of lymphocytic infiltration.

Pancreas and adrenal The arteries and arterioles show no pathological changes.

This, Case 11 is a tubular nephrosis with vascular hypertrophy.

Cases 7, 8, 9, 10 and 11 represent the clinical and pathological picture of toxemias of pregnancy occurring for what is presumed to be the first time. They all show the lesions characteristic of that condition. What is more important from the point of view of this study is that none shows the lesions of malignant nephrosclerosis. Case 11 and 10 to a much lesser degree, Case 9 with vascular hypertrophy might be considered as potential malignant nephrosclerotics in whom the time interval and the degree of damage were not yet sufficient for the development of the typical lesions.

For the sake of completeness two further cases are given brief description.

CASE 12 JHHU 6320 T 537 Patient, colored, aged 32 years, had had no pregnancies. She had typhoid at age of 18. At age of 28 years, not pregnant, blood pressure was 174/130. At age of 29 years, not pregnant, blood pressure was 154/88. At age of 32 she was first seen when 6½ months pregnant. Blood pressure was 190/120 and 170/110. Urine was negative for albumin. Four days later blood pres-

ure was 150/110. Eyegrounds were normal. The nolsulphonphthalein test showed 55 per cent excretion first hour 10 per cent second hour. Patient complained of vomiting. Sixteen days later she was still vomiting and blood pressure was 130/86. The pulse rose to 140-150 and blood pressure of 140/108 was recorded. Patient aborted a 9 months stillborn fetus. Throughout this time the blood non protein nitrogen was normal. The patient died. Clinical diagnosis chronic nephritic toxæmia.

Autopsy report was not available but a note was made by an observer from the obstetrical service to the effect that the right kidney showed marked destruction of the substance with multiple abscesses, no dilatation of pelvis of right kidney, left kidney showed many hemorrhagic areas and a few abscesses, few patches of broncho-pneumonia.

Microscopic examination. The kidney showed typical lesions of malignant nephrosclerosis. No abscesses were present. The vessels of the pancreas showed only hypertrophy of the media. The adrenal showed hypertrophy of the arteries of the capsule with marked arteriosclerosis and hemorrhage into the walls.

The lesions here are typical of malignant nephrosclerosis. The original damage was not associated with pregnancy since death occurred following the first of these. The pregnancy was however, implanted upon a pre-existing hypertension.

This case is not included in the consideration of the group of malignant nephrosclerosis for the reason that the observation of abscesses in the kidney was reported and none was found on microscopic examination. That it belongs in the group is reasonable to suppose but the uncertainty of identity has demanded a separate report.

CASE 13 J.H.I.L.U. 36650 T 532 This woman, aged 39 years, colored, had had 5 term pregnancies, 4 living children. At age of 13 years a term pregnancy was observed. The urine at one time contained $\frac{1}{2}$ gram albumin (Esbach). No further data. At age of 25 years term pregnancy, no data. At age of 26 years term pregnancy, blood pressure and urine normal.

At age of 29 years, term pregnancy, two blood pressures of 135/90 and 140/100 were recorded. Urine albumin trace once.

At age of 39 years, patient was admitted pregnant and close to term. She had complained of vomiting and headaches for 2 weeks. Two hours before admission she became comatose. Her mother had died of apoplexy. Eyegrounds, retinal edema bilateral. Blood pressure was 105/80. Urine showed albumin 4 plus, large numbers of red blood cells and white blood cells. Blood non protein nitrogen 103.5 milligrams per cent. Blood uric acid was 14.5 milligrams per cent. Hemoglobin was 16 per cent. White blood cells 15,000. Red blood cells 920,000. A caesarean section with hysterectomy was done. The patient died 4 days later of septicaemia complications, chronic nephritic toxæmia of pregnancy.

Autopsy showed chronic cystitis and pyelonephritis, organizing and fresh thrombi in the pelvic veins, multiple small emboli in lungs, confluent lobular pneumonia, acute splenic tumor, swollen liver with hydropic cells, hyperplasia of the bone marrow, multiple infected thrombi in the hypophysis with extensive necrosis, embolus in right middle cerebral artery, foci of fresh encephalomalacia with bacteria, local myocarditis, scars in myocardium, cholelithiasis, focal scars in liver.

Microscopic examination of kidney. Well preserved kidney showing moderate vascular hypertrophy. Superimposed upon this is a fresh degenerative and inflammatory reaction involving the tubules, glomeruli and stroma. Some of the capillaries of the glomeruli are filled with organisms. The tubules show granular and fatty degeneration of the cytoplasm of the epithelium. The stroma is edematous and contains polymorphonuclear leucocytes and lymphocytic exudate.

Pancreas. Vessels show no pathological change. There is a diffuse interstitial pancreatitis.

This patient died with septicaemia. As a result of this there is bacterial focal glomerulonephritis and simple tubular nephrosis with toxic edema of the stroma. There is also a mild simple arteriosclerosis with vascular hypertrophy which played no part in the fatal issue. Lesions of malignant nephrosclerosis are not present.

SUMMARY

1. The toxæmias of pregnancy frequently produce permanent vascular damage to the patient. Many of these women die in a short period of time. Statistical evidence of this from the literature is presented.

2. A clinical and histological study of all of the deaths indexed as from nephritis which have occurred on the obstetrical service of Johns Hopkins Hospital and from which pathological material was available is reported.

3. Two groups of cases have emerged: (a) Those in which the patient died during or immediately following a pregnancy complicated by a non-convulsive toxæmia and in whom no history of previous hypertension was obtained showed tubulonephrosis and in no case, the characteristic lesions described as malignant nephrosclerosis.

(b) The second group is made up of those patients who have suffered from a chronic nephritic toxæmia of pregnancy. In every case the hypertension has preceded the last pregnancy and has existed for from 2 to 7 years before death. Every patient in this group was found to present the characteristic lesions of malignant nephrosclerosis as described by Volhard and Fahr (1914) and Fahr (1934).

We wish to take this opportunity to express our appreciation to Professor W. G. MacCallum of the Department of Pathology, Johns Hopkins Hospital, for permission to use the material here presented.

BIBLIOGRAPHY

1. BAIRD and DUNN, J. *Path. & Bacteriol.* 1933, 37, 302.
2. BELL, E. T. *Am. J. Path.* 1932, 8.
3. FAHR, T. Henke u. Lubarsch, *Handbuch der speziellen pathologischen Anatomie*. 1935, 6, No. 1 and 1934, 6, No. 2.
4. HEDENMANN, T. *Zentralbl. f. Gynæk.* 1930, No. 18, 449; 1931, No. 24, 838.
5. HINCKELMANN, HARM. *Zentralbl. f. Gynæk.* 1931, No. 1, 71; 1931, No. 17, 603. *Eklampsie*. Berlin 1934.
6. PECKHAM, C. H. and STOUT, M. L. *Bull. Johns Hopkins Hosp.* 1931, No. 40, 225.
7. RUSSELL, DOROTHY S. Privy Council, Medical Research Council, Special Report Series 142. London, 1930.
8. SCHUERMANN, P. and MACCLINTON, H. E. *Arch. f. path. Anat.*, 1933, 47, Nos. 1-2.
9. STANDER, H. J. and PECKHAM, C. H. *Am. J. Obst. & Gynec.* 1931, 22, 626.
10. STANDER, H. J. *Am. J. Obst. & Gynec.*, 1936, 21, 583.
11. VOLHARD, F. and FAHR, T. *Die Brightsche Nierenkrankheit*. Klinik, Pathologie. Berlin Julius Springer 1914.
12. VOLHARD, F. *Handbuch der inneren Medizin*. Vol. 3. Berlin, 1931.
13. VON ZALKA, L. *Arch. f. path. Anat.* 1932-1933, 290, No. 53.

THE RECURRENT LARYNGEAL NERVES IN TOTAL ABLATION OF THE NORMAL THYROID GLAND

AN ANATOMICAL AND SURGICAL STUDY¹

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THE recurrent laryngeal nerves constitute the greatest technical hazard in total ablation of the normal thyroid gland. This procedure for the treatment of angina pectoris and congestive heart failure was recently advanced by Blumgart and his co-workers at the Beth Israel Hospital in Boston (5). Of a total number of more than 70 complete thyroidectomies 65 were performed for the relief of advanced cardiac disease and the encouraging results thus far achieved augur well for its useful application in angina pectoris and other forms of chronic heart disease. The operative technique and results have been reported elsewhere (2, 6).

The purpose of this communication is to call attention to the technical hazard of the recurrent nerve, pointing out its various vulnerable juxtapositions to the gland and thus to assist the surgeon in avoiding serious nerve injury with its consequent disastrous vocal cord complications. The extensive operation of removing the entire thyroid gland obviously presents a great risk of injury to the recurrent nerves. An accurate knowledge of the variations in the relationship of these nerves to the thyroid gland then is of vital assistance to the operator in the prevention of abductor paralysis. It is this variability of position rather than the vulnerability of the nerve itself that is responsible for the frequency with which it may be seriously injured.

ANATOMICAL DISSECTIONS OF THE RECURRENTS IN SEVENTY CADAVERS

During the past 2 years anatomical dissections were made of both recurrent laryngeal nerves in 70 cadavers. Particular study was made of the position of the nerve in relation to the thyroid gland and its adherent zone (Fig. 3b). In a previous communication (2) the latter area was described as an expression

of normal anatomy indicating the fixation of the gland to the trachea just below the antero-lateral aspect of the bar of the cricoid cartilage at the level of the first and second tracheal rings. The anatomical courses of the nerves were conveniently classified into three groups (Table I).

Group I The most hazardous position of the nerve in relation to the gland is shown in Figures 3c, 4a, 4b, and 5. Ten per cent, or 14, of a total of 140 nerves, were found partially penetrating the gland, 9 on the right side, 5 on the left. When encountered in this vulnerable position, the nerve is carefully dislodged by blunt dissection from its surrounding bed of glandular tissue.

Group II Approximately 25 per cent of the nerves were demonstrated traversing the adherent zone (Fig. 3b and 3d). 19 on the right and 16 on the left side. After mobilization of the corresponding lobe by the ligation and severance of the lateral thyroid vein and the vessels of the upper and lower poles, the adherent zone is brought into view. Subsequent traction on the lobe reveals the pronounced fixation of the gland to the trachea at this point. Frequently, the nerve is concealed in this region beneath a stratum of fibrofascial and fatty tissue. By careful exploration with a blunt instrument it is possible to identify and preserve the nerve uninjured.

Group III In our dissections, 65 per cent of the nerves were found coursing safely in the tracheo-esophageal sulcus, in which position the nerve is best protected against operative injury (Figs. 3a, 6a, and 6b). The classical anatomical textbooks in their description refer only to this position of the nerve, not mentioning either the possibility of partial penetration of the gland by the nerve or the important relationship existing between the nerve and the adherent zone.

This is the twelfth study of the treatment of chronic heart disease by producing a subnormal metabolic rate in patients with no evidence of thyrotoxicosis.

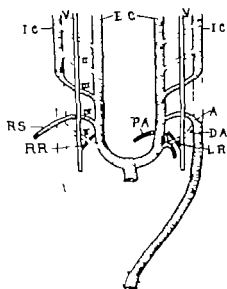


Fig. 1. Aortic arches of the embryo. (After Altmot.) The dotted lines represent those vessels which normally disappear. I C internal carotid artery E C external carotid artery V vortia P pulmonary artery DA ductus arteriosus RS right subclavian artery RR right recurrent laryngeal nerve LR left recurrent laryngeal nerve

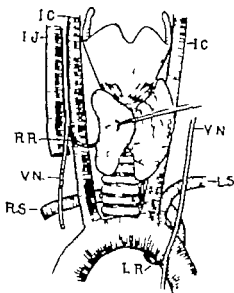


Fig. 2. Diagram of the common associated anomalies of the right recurrent laryngeal nerve and aortic arch. The right subclavian artery is shown arising as the last branch of the aortic arch and passing behind the trachea and oesophagus toward the right arm. RR Right recurrent laryngeal nerve V N vagus nerve LR left recurrent laryngeal nerve I J internal jugular vein I C internal carotid artery RS right subclavian artery L S left subclavian artery

COMPARATIVE SURGICAL OBSERVATIONS OF THE RECURRENT LARYNGEAL NERVE IN SEVENTY TOTAL ABLATIONS OF THE NORMAL THYROID

Observations were made in a total number of 72 recurrent nerves in the course of 70 total thyroidectomies. Table II demonstrates the different positions occupied by the nerve as demonstrated at the operating table. For the sake of comparison they are classified in a manner similar to those demonstrated in the anatomical laboratory (Table I). The percentages are calculated on the basis of the possible total of 140 nerves.

Group I Nine nerves (7 per cent) were demonstrated partially penetrating the gland. To release the recurrent nerve from this its most vulnerable position meticulous and deliberate dissection is required to avoid injury.

Group II Forty five nerves (32 per cent) 24 on the right and 21 on the left side were identified coursing through the adherent zone in a very intimate position to the gland necessitating careful blunt dissection for the intact preservation of the nerve.

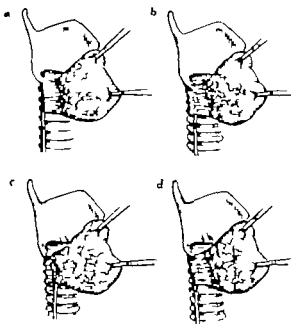


Fig. 3. Variations in the course of the recurrent laryngeal nerve. a, In tracheo-oesophageal sulcus. b, through adherent zone. c, partially penetrating gland. d, division of nerve.

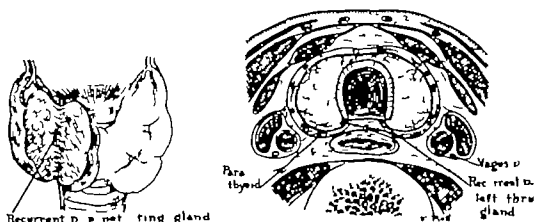


Fig. 4. Anteroposterior and cross section views showing partial penetration of the thyroid gland by the recurrent laryngeal nerve. Anteroposterior view and cross section demonstrating left nerve through the gland (after Gormley)

Group III Eighteen nerves were identified in the tracheo-oesophageal sulcus. Sixty-eight nerves were not identified at operation. Presumably they were safely concealed deep in the tracheo-oesophageal sulcus. When the thyroid was found deeply molded in the groove between the trachea and oesophagus, presenting either a retrotracheal or retrolaryngeal prolongation it was necessary to expose the course of the nerve in the sulcus to assure its protection. Fowler and Hanson

found 5 glands in 200 (2½ per cent) extending retrotracheally. In our operative series 4 glands (5.7 per cent) presented either retrotracheal or retrolaryngeal prolongations.

RELATIONS OF THE RECURRENT NERVE TO THE TRACHEA AND INFERIOR THYROID ARTERY

An observation made in the anatomical laboratory which has a practical surgical application concerns the relationship of the recurrent nerve to the lateral surface of the trachea. On the left side the nerve ascends in a vertical plane and is intimately applied to the trachea along its entire course in the neck. On the right side at the base of the neck, the nerve is frequently separated from the trachea to the average extent of about 1 centimeter, gradually approximating the trachea in its upward ascent and becoming closely apposed to the latter upon reaching the adherent zone. At the level of the lower pole the right nerve is often found thus separated from the trachea and in addition, usually travels in

TABLE I—CLASSIFICATION OF VARIOUS POSITIONS OF THE RECURRENT LARYNGEAL NERVES (ANATOMICAL DISSECTIONS OF BOTH NERVES IN 70 CADAVERS)

	Right	Left	Total Per cent
1 Partially penetrating gland	9	5	10
2 Through adherent zone	19	16	25
3 In tracheo-oesophageal sulcus	42	49	65
	70	70	100

TABLE II—CLASSIFICATION OF VARIOUS POSITIONS OF THE RECURRENT LARYNGEAL NERVES (SURGICAL OBSERVATIONS IN 70 TOTAL THYROIDECTOMIES)

	Right	Left	Total Per cent
1 Partially penetrating gland	5	4	7
2 Through adherent zone	23	20	31
a. Branching before entering larynx	1	1	1
3 In tracheo-oesophageal sulcus	8	10	13
4 Unidentified*	33	35	48
	70	70	100

* Presumably these nerves coursed beyond reach deeply in the tracheo-oesophageal sulcus.



Recurrent n penetrating gland

Fig. 5. Recurrent nerve partially penetrating gland.

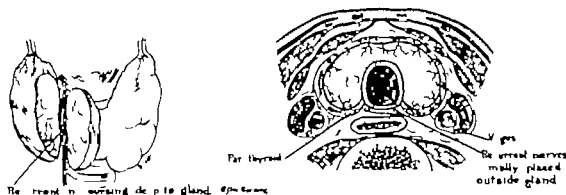


Fig. 6. Anteroposterior and cross section views demonstrating the recurrent laryngeal nerves coursing in the tracheo-esophageal sulcus deep to the gland.

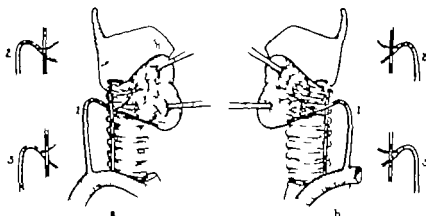


Fig. 7. Variations in the relationship between the nerve and inferior thyroid artery. a, Right side: 1. nerve anterior to artery; 2. nerve posterior to artery; 3. nerve passing between terminal branches. b, Left side: 1. nerve anterior to artery; 2. nerve posterior to artery; 3. nerve passing between terminal branches.

a more anterior plane than its fellow opposite. This vulnerable combination of anatomical relationships has been often observed at operation. If not recognized the nerve may easily be caught in a snap or accidentally cut.

The cartilaginous prominence of the inferior thyrocricoid articulation affords an especially valuable surgical landmark for identifying the location of the recurrent laryngeal nerve as it enters the cavity of the larynx. For each of the 140 nerves dissected was seen to pass posteriorly to this articulation. Ziegelman, in a dissection of 42 recurrent nerves, also observed that all of the nerves presented a similar relationship to the inferior cornua of the thyroid cartilage on both sides. It should be again emphasized however that the nerve may arch anteriorly traversing the adherent zone

or partially penetrating the gland before dipping beneath the cornu (Figs 3b, 3c, 4a and 5). Fortunately in the majority of instances (65 per cent) the nerve ascends vertically in the tracheo-esophageal groove on both sides, beyond harm's reach.

Twice the nerve was demonstrated branching into two terminal twigs at about the level of the lower pole, the anterior branch coursing through the adherent zone and ultimately joining its posterior terminal companion beneath the inferior thyrocricoid joint (Fig. 3d). One such reasonably sizeable anterior branch was accidentally cut at operation on the left side after first identifying the posterior twig which was thought to be the main stem of the nerve with a resultant partial temporary paralysis of the corresponding vocal cord.

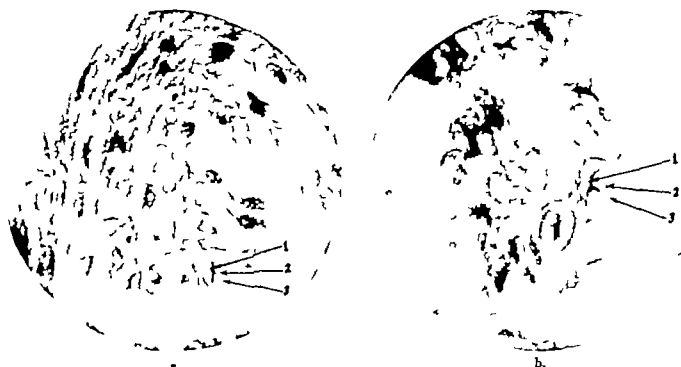


Fig 8. Histological resemblance between recurrent laryngeal nerve and an ordinary peripheral nerve. a, Recurrent laryngeal nerve. High power showing nerve fibers with 1 axis cylinders, 2 myelin sheath, and 3 neurolemmas. X925. b Subscapular nerve. High power showing nerve fibers with 1 axis cylinders 2 myelin sheath and, 3 neurolemmas. X925

In a previous publication (4) the results of 22 neck dissections disclosed, in a comparison of both sides a marked discrepancy in the relationship existing between the recurrent nerve and inferior thyroid artery. It was pointed out that the nerve was much more often anterior to the artery on the right side than on the left side. In this present series a reasonable but not so pronounced difference between the two sides was observed in the relationships of these structures (Figs 7a and 7b)

	Left	Per Cent	Right	Per Cent
Posterior to artery	44	63	31	44
Anterior to artery	17	24	28	40
Between terminal branches	9	13	11	16
	70		70	

It is obvious from this table that the nerve may frequently be anterior to the artery on either side and the surgeon must be constantly on the alert to recognize such variations when invading the danger zone in the final steps of total ablation of the thyroid gland

EMBRYOLOGY AND ANOMALIES OF THE RECURRENT LARYNGEAL NERVE

Accidental injury to the nerve is most likely to occur when its position is anomalous.

Fortunately however anomalies of the recurrent laryngeal nerve are rare. The only type which has been encountered in the literature is an anomalous course of the right recurrent nerve, which seems to occur in about 1 of every 500 persons. It appears to be more frequent in negroes (1). In the cases described, the nerve becomes separated from the main trunk of the vagus at about the level of the cricothyroid articulation. It may then run on in the carotid sheath for as much as 5 centimeters before passing medialward to the tracheo-oesophageal sulcus, up which it runs to a normal distribution as the inferior laryngeal nerve (1, 3, 10, 13, 14). In some instances the nerve may not actually exist as such, being replaced by several smaller filaments (1, 13). This anomaly has regularly been observed in association with an abnormal aortic arch, the right subclavian artery, instead of coming from the innominate of that side, arising either as the last branch of the aortic arch or from the dorsal aorta itself. In those cases to the reports of which we have had access the subclavian artery passed behind the trachea and oesophagus to the right arm (1, 14).



Fig. 9. a, Recurrent laryngeal nerve. Low power showing two fasciculi, 1 perineurium, and, 2 endoneurium $\times 75$
 b Subscapular nerve. Low power showing five fasciculi, 1 perineurium, and, 2 endoneurium $\times 75$

This association of anomalies is easily explained on an embryological basis. In Figure 1 (12) it will be seen that in the young embryo the inferior laryngeal nerves leave the vagus in the neck and pass medially and dorsally under the fifth aortic arch to the site of the larynx. In the normal course of events as the heart and the great vessels descend into the thorax the left nerve is dragged down by the ductus arteriosus, which eventually comes to lie in the vertical plane so that the nerve appears to hook around the aorta. The right nerve on the other hand is pulled down by the fourth arch which later becomes the subclavian artery. If the fourth aortic arch on the right side fails to develop and the subclavian artery of that side comes directly off the aorta, the right recurrent nerve has only the internal carotid artery above it. Thus in man is almost vertical in position and naturally does not pull the nerve down to any great extent so that the latter goes almost directly across the neck from vagus to larynx (Fig. 2).

One would expect that in persons with right sided aortas, any anomaly of the recurrent nerve would be on the left side. To our knowledge no such case has appeared in the literature, but the findings in one that was seen in the Harvard anatomical laboratory last winter were very kindly furnished by Dr. Weatherford of that school. There was a right sided aorta, from the dorsal portion of which the left subclavian artery sprang to pass

behind the trachea and oesophagus on its way to the left arm. On the right, the recurrent nerve looped around the aorta as would be expected. On the left however the nerve left the vagus at the level of the subclavian artery, looped around a strand of fibrous tissue in front of the vessel and ascended the neck in the tracheo-oesophageal sulcus as usual. To explain this anomaly we must assume that the fibrous tissue about which the nerve hooked represents the sclerosed remnant of either the fourth or fifth left aortic arch.

VULNERABILITY OF THE RECURRENT LARYNGEAL NERVE

Crile contends that the slightest direct or even indirect pressure on the nerve will interfere with its conduction and immediately change the voice. We have not observed this extreme sensitivity of the nerve to such slight trauma. While the possible inclusion of the recurrent nerve in a ligature is viewed with considerable fear its vulnerability because of certain characteristics in its conductivity (7) is not as great as has been supposed. This was our experience in 43 patients in whom one or both nerves were demonstrated at operation and subjected to manipulative insult such as would ordinarily attend this type of a dissection. There were 8 temporary vocal cord paralyses. Knowing that in some instances paresis followed the inadvertent pinching of the nerves, it seems probable that trauma of this character was responsible for the pareses.

in these instances. There were three permanent unilateral cord paralyses. One of these was proved at post mortem to result from ligation, another resulted from accidental section of the nerve. In no instance did permanent bilateral vocal cord paralysis develop.

The foregoing clinical observations are in accord with the animal experimental findings of Judd, New, and Mann, who demonstrated that while stretching will not result in any impairment of nerve function pinching will cause temporary paralysis of the corresponding cord, and that permanent cord paralysis will follow ligation or severance of the nerve.

The recurrent laryngeal nerve has been designated as being soft and naked, in contrast with a peripheral nerve (7). Histologically, there does not appear to be a valid basis for this differentiation (Figs 8a, 8b, 9a, and 9b). Both the recurrents and the peripheral nerves are furnished with a myelin sheath and a neurolemma (sheath of Schwann). A naked nerve is considered to be one devoid of these coverings. Furthermore, the perineurium or connective tissue element in the recurrent laryngeal nerve is essentially as abundant as in the average peripheral nerve, hence its firmness and tensile strength should be comparable to those of a peripheral nerve.

THE IMPORTANCE OF LARYNGOSCOPIC EXAMINATION IN THE COURSE OF OPERATION

Laryngoscopic examination preceding each operation should be a routine procedure in the management of all thyroid surgery, in order to assure pre-operative normality of the vocal cords and to enable one to ascertain more accurately the postoperative incidence of recurrent nerve damage. Injury to both recurrent laryngeal nerves is a calamitous, but fortunately an uncommon complication of subtotal resection of the diseased thyroid gland. There is greater likelihood however, of such a tragic accident developing in the process of totally extirpating the gland, for, whereas in the customary subtotal thyroidectomy the danger zone of the recurrent nerves and the parathyroid glandules is not particularly disturbed, in total thyroidectomy this zone is deliberately invaded (2). Thus, in the

latter operation both nerves are exposed to the greatest possible harm, and the danger of bilateral nerve injury must be always regarded as imminent. As a precaution against the development of such a complication, a direct laryngoscopic examination of the vocal cords is made routinely after the removal of one lobe (9). This applies to cases in which operation has been done under local, as well as general anesthesia, for on occasion the voice may be apparently normal even in the presence of one sided nerve injury. The quality of the spoken voice, therefore, is not a reliable guide to the integrity of the recurrent nerve on the corresponding side operated upon. Such false reliance on the changes in the character of the voice may lead to serious consequences. In the face of vocal cord paralysis after extirpation of one lobe, operation is ended to avoid the possibility of bilateral nerve injury. In two patients this procedure was followed with subsequent return of function of the injured recurrent nerve, and successful removal of all remaining thyroid tissue at a second operation.

Recently, at the suggestion of Dr. L. M. Freedman, we have desensitized the throats of patients operated upon under local anesthesia by applying cocaine immediately preceding operation in order to alleviate the discomfort of direct laryngoscopic examination during operation.

SUMMARY

1. Attention is called to the increased danger of injury to the recurrent laryngeal nerve in total ablation of the thyroid gland over that present in partial thyroidectomy.

2. The recognized type of gross anomaly in the course of the nerve is described and an embryological explanation for it is offered.

3. A report of the dissections of 140 recurrent nerves in 70 cadavers is presented. The nerves are classified into three groups as they are found in the tracheo-oesophageal sulcus traversing the adherent zone or partially penetrating the thyroid gland itself. The incidence of the latter two positions is found to be sufficiently great to demand the concern of the surgeon constantly. Operative experience confirms these observations.

4 The importance of the inferior thyro-cord articulation as a guide to the location of the recurrent laryngeal nerve is strongly emphasized

5 Although the nerve is found to be anterior to the inferior thyroid artery more often on the right than on the left the disproportion is not extremely marked and this position of the nerve should be watched for on both sides of the neck

6 Clinical and histological evidence is presented to show that the recurrent laryngeal nerve closely resembles an ordinary peripheral nerve and that its vulnerability to trauma is not as great as previously supposed. It is felt that an accurate knowledge of the variable positions of the nerves is the essential factor in the prevention of bilateral injury to the nerve

7 The quality of the spoken voice cannot be relied upon to denote the presence of unilateral nerve damage. The necessity therefore for direct laryngoscopic examination after ablating one lobe of the thyroid as a prevention against bilateral vocal cord paralysis is again emphasized

I desire to express my appreciation to Dr Charles G. Mitter, surgeon in chief of the Beth Israel Hospital, for his encouragement throughout this work.

I am indebted to Dr Monroe J. Schlesinger, pathologist at the Beth Israel Hospital, for the preparation of histological material.

BIBLIOGRAPHY

ADACHI B. Das Arteriensystem der Japaner. Kyoto, 1938.
 2. BERLIN D D. Therapeutic effect of complete thyroidectomy on congestive heart failure and

angina pectoris in patients with no clinical or pathological evidence of thyroid toxicity. II. Operative technique. *Am J Surg* 1933, 51 173.
 3. Idem. Unpublished anatomical observation.
 4. BERLIN D D and LANEY, F H. Directions of the recurrent and superior laryngeal nerves. *Surg Gynec. & Obst* 1929, 49 103.
 5. BLUMHART, H L, LEVINE, S A and BERLIN D D. Congestive heart failure and angina pectoris. The therapeutic effect of thyroidectomy on patients without clinical or pathologic evidence of thyroid toxicity. *Arch Int Med* 1933, 51 866.
 6. BLUMHART, H L, RHEIMAN J E, F DAVIS, D and BERLIN D D. Therapeutic effect of total ablation of normal thyroid on congestive heart failure and angina pectoris. III. Early results in various types of cardiovascular disease and coincident pathologic states without clinical evidence or pathologic evidence of thyroid toxicity. *Arch Int Med* 1933, 52 165.
 7. CRILE, G. Diagnosis and treatment of the thyroid gland. p. 403. Philadelphia W B Saunders Co 1932.
 8. FOWLER, C H and HANCOCK W A. Surgical anatomy of the thyroid gland with special reference to the relations of the recurrent laryngeal nerve. *Surg Gynec. & Obst* 1929, 49 39.
 9. FREEDMAN L M. Treatment of angina pectoris and congestive heart failure by total ablation of the thyroid. V. Importance of laryngoscopic examination as a means of preventing bilateral paralysis of the vocal cords. *Arch Otolaryngol* 1934, 19 383.
 10. HOOVER, F H. The anatomy and physiology of the recurrent laryngeal nerve. *New York M J* 1887, 46 29.
 JUDS F S, NEW G B and MANN, F P. Effect of trauma on laryngeal nerve. *Ann Surg* 19 8 68 257.
 MINOT, C S. Human Embryology. p. 334. New York. The Macmillan Company, 1897.
 13. PENNINGTON J DE J and BEAVER, M O. Anomaly of the right recurrent laryngeal nerve. *Surg Gynec. & Obst* 1932 54 504.
 14. PIERCE, G A. Human Anatomy. 4th ed. p. 1272. Lippincott.
 5. ZIEGLERMAN E F. Laryngeal nerves. Surgical importance in relation to the thyroid arteries, the thyroid gland and the larynx. *Arch Otolaryngol* 1933 18 793.

ALTERATIONS IN LIVER GLYCOGEN FOLLOWING THYROID, IODINE, AND GLUCOSE FEEDINGS

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OF the numerous conditions in clinical practice in which a serious depletion of the liver glycogen may play an important part, none is more frequently encountered than is hyperthyroidism. Although the exact relation of thyroid function to the regulation of carbohydrate metabolism is as yet a moot point, there is sufficient available evidence published by different investigators—Cramer and Krause, Boesl, Zimmerman, and Knittel—to state that the feeding of desiccated thyroid extract to the cat, rat, mouse, guinea pig or rabbit results in a reduction of the liver glycogen.

While certain of these investigations may be criticized because of failure more adequately to control the conditions surrounding the experiments, the data may be accepted as a whole as there is no essential disagreement between them.

We were primarily interested in whether or not the liver glycogen would be increased in the presence of experimental hyperthyroidism by the addition of glucose to the normal diet. During these investigations we have also had the opportunity to obtain additional evidence on the effect of the iodides on the circulating thyroxin.

METHOD

The animals used in these experiments were guinea pigs from one stock. They weighed from 400 to 600 grams. Purina rabbit pellets, which contain approximately 16.5 per cent of protein, 4 per cent of fat, 52.8 per cent of nitrogen free extract and 7.8 per cent of fiber were used for feeding. The pellets were pulverized and remolded into squares containing approximately 16 grams.

When thyroid extract, potassium iodide or glucose was added to the diet, it was mixed with the pellets during the process of pulverizing.

The pigs were weighed daily at the same time before feeding. Special feedings were as a rule not begun until each group had been

observed carefully for at least 1 week and the animals had shown a normal weight increase during this period. In the special feeding experiments, only data from those animals which ate all the food given them are included.

After a variable period of feeding, the pig was stunned by a cranial blow, the abdomen immediately opened, a small piece of liver rapidly removed and dropped into 5 cubic centimeters of a 40 per cent solution of sodium hydroxide, which had previously been placed in a 50 cubic centimeter centrifuge tube and weighed. The tube with the sodium hydroxide and piece of liver was immediately reweighed to obtain the weight of the liver sample.

The time from stunning the pig until the liver sample was placed in the sodium hydroxide never exceeded one minute and as a rule was less than 30 seconds. Duplicate samples were run in each experiment.

The extraction of glycogen from the liver was carried out by Sahyun's modification of the Pflueger method. After extraction of the glycogen and its conversion into glucose, the latter was determined by the Somogyi modification of the Shaffer Hartman method.

RESULTS

Control guinea pigs. The pigs used in this group were fed the standard diet for 6 to 19 days. They gained in weight and were in excellent condition at the time they were killed. The last feeding was given 24 hours before death although the animals ate food over a part of this period. The data from the animals in this group are given in Table I. Each pig gained in weight. The liver glycogen varied from 3.2 to 8.6 per cent.

Thyroid fed guinea pigs. The animals in this group received in addition to the standard diet 0.5 gram of desiccated thyroid extract¹ daily, after a trial period on the standard diet during which they gained in weight. The

¹ Park, Davis & Co.

4. The importance of the inferior thyrocricoid articulation as a guide to the location of the recurrent laryngeal nerve is strongly emphasized.

5. Although the nerve is found to be anterior to the inferior thyroid artery more often on the right than on the left the disproportion is not extremely marked and this position of the nerve should be watched for on both sides of the neck.

6. Clinical and histological evidence is presented to show that the recurrent laryngeal nerve closely resembles an ordinary peripheral nerve and that its vulnerability to trauma is not as great as previously supposed. It is felt that an accurate knowledge of the variable positions of the nerves is the essential factor in the prevention of bilateral injury to the nerve.

7. The quality of the spoken voice cannot be relied upon to denote the presence of unilateral nerve damage. The necessity, therefore, for direct laryngoscopic examination after ablating one lobe of the thyroid as a prevention against bilateral vocal cord paralysis is again emphasized.

I desire to express my appreciation to Dr. Charles G. Minter, surgeon in chief of the Beth Israel Hospital, for his encouragement throughout this work.

I am indebted to Dr. Monroe J. Schlesinger, pathologist to the Beth Israel Hospital, for the preparation of histological material.

BIBLIOGRAPHY

- ADACHI B. Das Arteriensystem der Japaner. Kyoto 1915, 36.
- BERLIN D. D. Therapeutic effect of complete thyroidectomy on congestive heart failure and angina pectoris in patients with no clinical or pathological evidence of thyroid toxicity. II. Operative technique. *Am J Surg* 1933 31 173.
- Idem. Unpublished anatomical observation.
- BERLIN D. D. and LARRY F. H. Dissections of the recurrent and superior laryngeal nerves. *Surg. Gynec. & Obst.* 1930, 49 103.
- BLUMHART H. L., LEVINE, S. A. and BERLIN D. D. Congestive heart failure and angina pectoris. The therapeutic effect of thyroidectomy on patients without clinical or pathologic evidence of thyroid toxicity. *Arch. Int. Med.* 1933 51 866.
- BLUMHART H. L., RISEMAN J. E. F., DAVIS, D. and BERLIN D. D. Therapeutic effect of total ablation of normal thyroid on congestive heart failure and angina pectoris. III. Early results in various types of cardiovascular disease and coincident pathologic states without clinical evidence or pathologic evidence of thyroid toxicity. *Arch. Int. Med.* 1933 53 165.
- CHALK, G. Diagnosis and treatment of the thyroid gland. p. 403. Philadelphia W. B. Saunders Co. 1932.
- FOWLER, C. H. and HUTTON W. A. Surgical anatomy of the thyroid gland with special reference to the relations of the recurrent laryngeal nerve. *Surg. Gynec. & Obst.* 1929 49 59.
- FRANKMAN L. M. Treatment of angina pectoris and congestive heart failure by total ablation of the thyroid. V. Importance of laryngoscopic examination as a means of preventing bilateral paralysis of the vocal cords. *Arch. Otolaryngol.* 1934, 19 383.
- HOOVER, F. H. The anatomy and physiology of the recurrent laryngeal nerve. *New York M. J.* 1887 46 29.
- JUDY F. S., NEW G. B. and MARY F. P. Effect of trauma on laryngeal nerve. *Ann. Surg.* 19 8, 68 357.
- MINOT, C. S. Human Embryology p. 534. New York The Macmillan Company 1897.
- PICKERINGTON J. DE J. and BEAVER, M. G. Anatomy of the right recurrent laryngeal nerve. *Surg. Gynec. & Obst.* 1932 54 594.
- PICCOLI, G. A. Human Anatomy 4th ed. p. 1373. Lippincott.
- ZIEGLERMAN E. F. Laryngeal nerves. Surgical importance in relation to the thyroid arteries, the thyroid gland and the larynx. *Arch. Otolaryngol.* 1933 18 793.

we are reporting add additional evidence to Kunde's data and furthermore show that as long as the thyroid hormone gains access to the blood stream the liver stores of glycogen continue to be markedly reduced. The observations of Marine and of Frazier and Mosser that the beneficial effect of iodine in hyperthyroidism is the result of its effect on the thyroid gland itself would seem to be strengthened.

Of considerable importance are the data relating to the inability to increase the glycogen store of the liver during marked hyperthyroidism. It would seem that the effort to do this is wellnigh worthless unless the hyperthyroidism can be controlled either with iodine or operation or both.

Operation for hyperthyroidism without question throws an additional load on glycogen stores which are reduced in severely ill patients even under the best of conditions. Therefore, the value of attempting to restore the liver glycogen by the judicious use of carbohydrates immediately after operation should be emphasized. The intravenous method would at this time seem to offer the most rapid means of doing this in patients very ill after operation. In this regard the observations of Frazier and of North are extremely interesting.

CONCLUSIONS

- 1 The addition of thyroid extract to guinea pigs receiving a diet, which without the thyroid extract permits of a gain in weight, results in a depletion of the liver glycogen.
- 2 The addition of iodine to the diet of an animal receiving thyroid extract fails to prevent the depletion of the glycogen stores of the liver.
- 3 The addition of glucose to the standard diet of guinea pigs receiving thyroid extract fails to restore the liver glycogen.
- 4 The implications of these data with respect to the management of patients with hyperthyroidism have been pointed out.

BIBLIOGRAPHY

1. BOEHL, O. *Biochem. Ztschr.*, 1928 202 299.
2. CRAMER, W. and A. K. KRAUSE. *Proc. Roy. Soc.* 1913 86B 550.
3. FRAZIER, C. H. *Am. J. Med. Sc.*, 1931 182 378.
4. FRAZIER, C. H. and W. B. MOSSER. *Ann. Surg.* 1929, 89 849.
5. KNITTEL, G. *Ztschr. f. d. ges. exper. Med.* 1931 76 363.
6. KUNDE, M. *Am. J. Physiol.* 1927 82 195.
7. MARINE, D. *Medicine*, 1927 6 127.
8. NORTH, J. P. *Penn. M. J.*, 1933 36 495.
9. PFLEUGER, E. *Arch. f. d. ges. Physiol.* 1904 103 169.
10. SAEYON, M. *J. Biol. Chem.* 1931 93 227.
11. SHAFFER, P. A., and A. F. HARTMAN. *J. Biol. Chem.* 1920-1921 45 340.
12. SOMOGYI, M. *J. Biol. Chem.*, 1926 70 599.
13. ZIMMERMANN, F. *Biochem. Ztschr.*, 1929 206 360.

STUDIES IN BONE SARCOMA

III AN EXPERIMENTAL AND PATHOLOGICAL STUDY OF THE RÔLE OF THE PERIOSTEUM IN THE FORMATION OF BONE IN VARIOUS PRIMARY BONE TUMORS

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IN the literature on primary tumors of bone there is considerable discussion concerning histogenesis, especially in regard to new bone formation. As again pointed out in a previous article (2) the group of primary bone neoplasms characterized by extensive atypical new bone formation in the primary growth and similar new bone formation in the soft tissue metastases affords conclusive evidence for the existence of the osteoblast or bone forming cell since these neoplasms represent a malignant degeneration of this cell. No other explanation can account for these tumors much less the explanation offered by the humoral school of osteogenesis which maintains that new bone formation in osteosarcomata is the result of a reprecipitation in the tumor of calcium absorbed from the osseous site of the tumor growth (5). Brunschwig and Harmon (3) showed that injection of calcium in several forms into growing transplantable soft parts sarcoma did not induce new tumor bone formation. In addition to new bone of tumor cell origin reactive bone or bone not formed by the activity of tumor cells, is often described in various types of primary bone sarcoma. In the literature there is little definite information concerning the source of this new non tumor bone, its relationship to tumor bone and to the tumor cells. Many years ago Ribbert pointed out that at the margins of extracortical portions of tumors of central origin there was an area of newly formed non tumor bone. This he stated was due to elevation of the periosteum by the adjacent expanding tumor mass (PL in Fig 12). These regions of newly formed non tumor bone are always sought for in roentgenograms when the diagnosis of bone tumor is considered. These areas have been called 'periosteal lipping' or "reactive tri-

angles. Ribbert made no attempt to correlate the cell type of the primary tumor and the extent of periosteal lipping nor did he attempt to determine a possible relationship between the elevated periosteum and new non-tumor bone formation within the tumor. The only additional observation made by this author was that tumor cells invading these reactive triangles destroy most of the newly formed non tumor bone leaving some fragments that are incorporated in the tumor mass as it expands in all directions.

The problem of the histogenesis of primary bone tumors would be greatly facilitated were it possible to cause malignant degeneration of a given type of cell in the bone of an experimental animal and compare the morphology of the resulting tumor with those observed in man. Such experiments not being technically possible at the present time it was decided to mimic them by placing fragments of a transplantable mesoblastic tumor in various locations in bone and observing the resulting neoplasm. These tumors correspond to the malignant degeneration in bone of mesoblastic cells which themselves, do not form bone.

EXPERIMENTAL

The transplantable neoplasm employed which originated in the abdominal wall is known as rat tumor 256 and was kindly furnished by Dr. Roscoe R. Hyde of the School of Hygiene of the Johns Hopkins University. Microscopically it is composed of round and spindle cells of various sizes the latter producing collagen. Numerous mitotic figures are present. The tumor grows at first by expansion and later infiltrates the surrounding tissues. Regional lymphatic and pulmonary metastases are produced in the later stages of growth. Successful transplantation is pos-

sible to almost all species of rats in over 75 per cent of the inoculations. Tubes of Rose now's beef broth and brain medium remained sterile for 3 weeks after inoculation with small fragments of the neoplasm. The tumor is not filterable even through Berkefeld V candles. Young adult white rats were used in the experiments. All operations were performed under aseptic conditions and ether anesthesia.

EXPERIMENT I

A. Small fragments of the sarcoma were placed beneath the periosteum of the shaft of the femur in three rats.

B. The knee joint was opened a sharp probe forced upward into the medullary cavity of the femur through its distal articular surface, and an elongated fragment of tumor pushed into the central portion of the femoral shaft in five rats.

C. A minute opening was made in the anterior crest of the tibia about 1 centimeter from the knee joint and a small fragment of tumor inserted into the medullary cavity in ten rats.

Four weeks after implantation, the extremities operated upon exhibited large tumor masses arising from the bone that seriously interfered with the function of the member. The animals were sacrificed at this time and the tumor masses were found to surround the bone into which transplantations had been made. The tumor adjacent to the shafts contained newly formed bone but roentgenograms were unsatisfactory in demonstrating its pattern because of the fine structure. Blocks of tumor including the shaft of the bone were fixed in formalin, decalcified, embedded in celloidin, sectioned and stained by hæmatoxylin and eosin and by phosphotungstic acid hæmatoxylin (Mallory).

Microscopic examination (Figs. 1 and 2) reveals that the tumor has grown through the cortex producing areas of absorption. Beyond the cortex, the accumulation of neoplastic cells elevated the periosteum for some distance. Finally the tumor has grown through and beyond the periosteum. In that portion of the tumor between elevated periosteum and cortex there are fine trabeculae of bone radiating at right angles to the surface of the

shaft. Between the elevated periosteum and cortex there are numerous fine connective tissue strands. It is in these strands near the shaft that the new bone has been laid down although on cursory examination it may seem that the bone was produced by metaplasia of the tumor cells (Fig. 4). Adjacent to the cortex these bony trabeculae appear quite mature, but as they are followed peripherally they become less mature in appearance and finally become continuous with bands of osteoid tissue. The latter in turn are continuous with the fine fibrous strands that extend to the periosteum. These strands appear to be fibers of Sharpey that have become elongated as the periosteum was elevated and thus maintained their connections between this membrane and the cortex.

The newly formed bone differs considerably in appearance in different zones in the same section. In places there are well defined bony trabeculae similar to those of normal cancellous bone. Elsewhere, the bony trabeculae are straight, long, and slender. There are also small areas in which recently precipitated calcareous granules are present about large rounded cells forming a lace like network in the intercellular spaces and presenting a picture not unlike the atypical tumor bone seen in malignant osteoblastomata in man (Fig. 4). Areas of cartilage are also present beneath the elevated periosteum in some of the sections (Fig. 5). Osteoid tissue when present is always between the most peripheral portion of the bony spicules and raised periosteum (Fig. 3).

In sections from some specimens, the periosteum is elevated over a considerable portion of the shaft, but there is not the extensive new bone formation throughout the subperiosteal zone as described above. Instead, there are scattered groups of radiating bony trabeculae and irregular islands of bone and cartilage. There is no apparent explanation for the differences in quantity of new bone in the different specimens although the extent of periosteal elevation was about the same in all cases.

It is stated above that the newly formed bone was of periosteal origin. This conclusion was based upon low power study of the

sections in which all the bone was found to be present only in the subperiosteal portions of the tumor. However from a microscopic study alone of the new bone under the higher powers especially those areas of atypical bone, it is impossible to state definitely that the tumor cells do not become incorporated into the bone since in many places they apparently can be seen in all stages of inclusion by bone as bone cells. Yet if actual metaplasia of tumor cells into bone cells did occur a true osteoblastic osteogenic sarcoma would have been formed. This however was not the case (see Experiment 1).

In addition to elevation and stimulation of the periosteum to new bone formation the tumor has also stimulated endosteal new bone formation. Short trabeculae of new bone are present radiating into the marrow cavity from the inner surface of the cortex. The cortex itself included within the tumor shows scattered areas of absorption a process like waste stimulated by growth of the neoplastic cells through it.

EXPERIMENT 2

Fragments of tumor including newly formed bone were obtained from the inoculated femur of some of the animals used in previous experiment and implanted beneath the skin into the liver the deep thigh muscles and dropped into the peritoneal cavity of other rats.

Two weeks later the animals were sacrificed. Sections of the tumors revealed that the neoplasm had grown profusely true to the original histological type. The fragments of bone were either completely absorbed or remained as small dead spicules in the centers of the tumor masses. Thus this bone behaved as does an ordinary bone homotransplant to subcutaneous tissue. This is additional evidence that all the bone formed in Experiment 1 was periosteal in origin and that the bone cells were not tumor cells, although histological study might have warranted such conclusions. Had the tumor cells become bone forming cells some of them would have continued growth as such in these transplants and have reproduced bone just as it is produced in ossifying metastases from certain osteogenic sarcomata (malignant osteoblastomata).

EXPERIMENT 3

A segment of bone 3 millimeters long was removed from the midshaft of the femur in each of 10 young adult rats, the contents of the medullary cavity removed and a small fragment of tumor pushed into the cavity. These segments were placed in the subcutaneous tissues of the flank in 10 other rats.

Three weeks later the tumors had become 2 to 4 centimeters in diameter. The rats were sacrificed and sections revealed that in 6 instances the segment of bone in the center of the tumor had died the neoplasm growing about it as a soft tissue sarcoma. In 4 instances the bone transplant also died but there had developed spicules of bone radiating from the surface of the dead segment similar to those seen in Experiment 1. The tumor had grown beyond and incorporated this new bone. Here again the new bone is formed from the periosteum which is elevated from the surface of the cortex by growing tumor. That in 6 instances no new bone formation is seen can probably be accounted for by the fact that revascularization of the osteoperiosteal transplant did not take place soon enough for survival of the periosteum.

EXPERIMENT 4

Periosteum was stripped from the femur from each of 5 young rats, wrapped about small fragments of tumor and placed in the subcutaneous tissues of other animals. Three weeks later gross and histological examination of the resulting tumors revealed no evidence of new bone or osteoid tissue.

OBSERVATIONS ON PRIMARY BONE TUMORS IN MAN

In the experiments described it was demonstrated that malignant mesoblastic cells growing from bone and not possessing osteoblastic properties, may elevate the periosteum and cause it to form bone. This bone is present in the form of spicules radiating at right angles from the surface of the cortex and is laid down in the tumor within fine connective tissue strands that extend from elevated periosteum through the mass of neoplastic cells to the surface of the cortex. All stages of osteogenesis are present depending



Fig 1 Experiment 1 Photomicrograph of sagittal section through upper portion of rat tibia. A fragment of tumor had been implanted into the medullary cavity 4 weeks previously. The neoplasm has grown outward in all directions, through the cortex elevating the periosteum. A Radiating trabeculae of periosteal new bone within the extracortical portions of the tumor B Endosteal new bone formation C Elevated periosteum D Neoplasm that has extended beyond elevated periosteum and contains no new bone E Absorption of cortex by the neoplasm $\times 12$



Fig 2 Photomicrograph of cross section of rat tibia into the medullary cavity of which a fragment of transplantable sarcoma had been implanted 4 weeks previously. A Elevated periosteum B New bone of periosteal origin in tumor C Tumor that has grown beyond elevated periosteum and contains no new bone D Cortex absorbed by growth of tumor through it $\times 12$

upon the area inspected. A short distance beneath the periosteum osteoid tissue and islands of cartilage may be present. Nearer the cortex the bone is more mature. Adjacent to the cortex the bone resembles normal cancellous bone.

The pattern of new bone formation in these experimental neoplasms is quite similar to that seen in certain types of bone sarcoma in man especially those forms of Ewing tumor in which there are fine strands radiating from the surface of the cortex. Soft tissue metastases from Ewing tumors do not produce bone thus showing that all the bone in the primary neoplasm is of non tumor origin.

Study of a large Ewing tumor of the upper half of the humerus removed from a 13 year old girl (Fig 7), shows precisely the same general morphology presented by the tumors produced in Experiment 1. The neoplasm was apparently of central origin, grew outward through the cortex elevating the periosteum for some distance from the shaft, stimulated osteogenesis and finally grew through and beyond the periosteum. A study of the gross specimen (Fig 7) shows the elevated periosteum with the new bone beneath it in the form of radiating trabeculae. Roentgenograms (Fig 8) show the uniform height of the trabeculae, indicating also the limits of the elevated periosteum within the tumor.

Microscopic examination shows compact masses of round tumor cells situated between



Fig. 3 Photomicrograph of a region in the extracortical portion of the neoplasm shown in Figure 2 showing: *A* elevated periosteum; *B* new bone; *C* osteoid tissue in region between elevated periosteum and new bone. $\times 75$

the straight trabeculae of non tumor bone that extend to the elevated periosteum. There are no areas in which the tumor cells vary in type to become spindle shaped and to appear to undergo osseous metaplasia. Some authors (Kolodny) however have incorrectly we believe stated that new bone in Ewing's tumors is both tumor bone and non tumor bone. All Ewing tumors do not exhibit the radiating spicules of bone that give the so called sun burst effect in roentgenograms. Some of them although of central origin are predominately osteolytic and when the periosteum is elevated by them they do not



Fig. 4 Photomicrograph of another region of extracortical portion of tumor shown in Figure 2 showing calcareous deposits about cells. This is an early stage of new bone formation in the tumor and from the histological examination alone it is not possible to state whether this is new bone of periosteal origin or whether it represents typical bone of tumor cell origin. $\times 135$

stimulate its osteogenic properties to any appreciable extent. Roentgenologically such neoplasms are indistinguishable from fibrosarcomas of bone. The so called "onion" layers seen in roentgenograms of Ewing's and other neoplasms of bone is due, we believe to alternating periods of rapid and slow growth. When the neoplasm grows rapidly no new bone may result or there may be a few radiating strands. When there is a period of relatively slow growth, the periosteum has an opportunity to form a layer of



Fig. 5 Photomicrograph of extracortical portion of a bone sarcoma produced in experiment 1 showing: *A* elevated periosteum; *B* tumor that has grown beyond the periosteum; *C* an island of "tumor" cartilage. This cartilage is in reality of periosteal origin, formed by elevation of this membrane and quite analogous to the cartilage seen in the callus developing about a fracture. $\times 60$



Fig. 6 Photomicrograph which illustrates experiment 3, a transplant consisting of bone and tumor into soft parts. New bone *C* has been formed by elevation of *A*, periosteum from surface of *B*, a transplanted segment of femur. *D* Neoplasm which is growing about transplanted segment of femur and which contains no new bone. $\times 5$

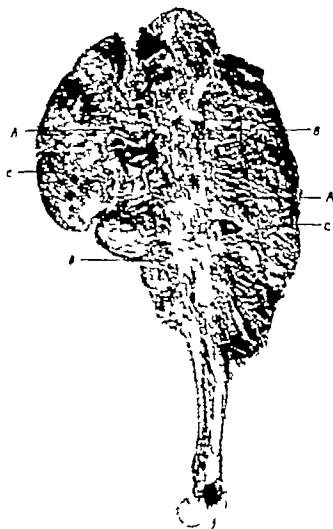


Fig 7 Photograph of split humerus showing large Ewing tumor in upper portion. *A* and *A'* periosteum elevated by expansile growth of tumor. *B* and *B'* newly formed bone present as fine spicules radiating from the cortex of the shaft (Roentgenogram in the following illustration) and confined to the subperiosteal zone. *C* and *C'* portions of the neoplasm that have grown through and beyond elevated periosteum and therefore contain no new bone.

bone analogous to an involucrum in osteomyelitis.

In those osteogenic sarcomata in which the tumor cells themselves have osteoblastic properties as shown by their ossifying metastases to soft tissues the greater part of the newly formed bone in the primary growth is of tumor cell origin. Yet periosteal elevation may also be an important factor in new bone formation in the primary tumor as in the following case. A densely ossifying osteogenic sarcoma in the upper end of the tibia produced ossifying metastases in the inguinal lymph nodes and lungs. There is extensive new tumor bone formation throughout the intramed-



Fig 8 Roentgenogram of specimen of Ewing tumor primary in the humerus (specimen shown in Fig 7) showing radiating trabeculae of periosteal new bone. The rather uniform height of the radiating trabeculae indicates the level of the elevated periosteum. The peripheral portion of the tumor does not contain new bone because it has grown through and beyond the periosteum. *PL* and *PL'* Periosteal lifting new bone formed by elevation and stimulation of periosteum by adjacent expanding tumor mass.

ullary and extracortical portions of the tumor as shown in Figure 9 which is a roentgenogram of a sagittal slice of it. Figure 10 is a microscopic section of the slice. It shows the periosteum elevated posteriorly over the tumor by the expansile growth of the extracortical portion. Much new bone formation of periosteal origin is also present in the tumor. Study of the deeper regions of the extracortical portion of the neoplasm shows bony trabeculae, extending from the cortical surface that are obviously of periosteal origin, having been laid down as this membrane was being elevated by the expansile growth of the tumor mass. In these deeper regions the periosteal bone is being absorbed by tumor in the same manner as is the normal bone of the shaft included within the tumor.



Fig 9. Roentgenogram of slice of osteogenic sarcoma in upper end of tibia, section of which is reproduced in following illustration. Note new bone formation in extra-cortical and intramedullary portions of tumor. The new bone in the extra-cortical portion is both of periosteal and tumor cell origin.



Fig 10. Photograph of sagittal section 25 micra in thickness from osteogenic sarcoma in upper portion of tibia. There were also ossifying metastases in the inguinal lymph nodes and lungs. P and P' Periosteum elevated posteriorly by expansile growth of tumor. S Region from which higher power photomicrograph was made (see Fig 11). M and M' limits of intramedullary portion of tumor. X

On microscopic examination of limited areas of neoplasms such as just described mature bone of tumor cell origin may sometimes not be distinguished from non-tumorous mature bone (Phemister 7). Conversely as shown by the experimental tumors, there may be areas of new bone of periosteal origin that are very atypical (Fig 4) and that resemble atypical bone of tumor cell origin. But where large sections are made through the entire neoplasm, the general topography of the newly formed bone in relation to periosteum and tumor cells is of considerable assistance in making a more accurate interpretation of the histogenesis of this bone.

Peripheral or periosteal osteogenic sarcomata arise from malignant degeneration of osteogenic cells (osteoblasts) in the periosteum or peripheral portion of the cortex. Figure 13 is a roentgenogram of a sagittal section

through the lower third of a femur bearing such a tumor. The neoplasm apparently arising in the posterior surface of the bone did not extend inwardly; the marrow cavity is free from tumor. Instead it had literally wrapped itself about the lower portion of the shaft and infiltrated adjacent muscles and fascia. Microscopic examination shows it to be composed principally of mature bone and large islands of hyaline cartilage some of which are undergoing ossification. This specimen illustrates how a peripheral osteogenic sarcoma involving periosteum at its point of origin may grow about other portions of the shaft on top of the periosteum. Thus the new bone within it, although in this case of mature appearance is entirely of tumor cell origin since the periosteum was not elevated. Figure 14 is a section from region S of Figure 13 showing the cortex with its periosteum



Fig 11 Photomicrograph of peripheral area of extra-cortical portion of osteogenic sarcoma in upper end of tibia, taken in region indicated in Figure 10. *P* Periosteum that has been elevated by expansile growth of tumor *PB* Periosteal new bone formation overlying peripheral margin of tumor *TB* Atypical bone of tumor cell origin situated within masses of neoplastic cells *PB* Trabeculae of periosteal bone that were formed as periosteum was being elevated by expansile growth of tumor. The spaces between these trabeculae are now invaded by neoplastic cells and this bone of non tumorous origin is thus situated within the neoplasm itself and alternates with areas of atypical bone of tumor cell origin (*TB* and *TB'*) $\times 6$



Fig 12 Photomicrograph of section through upper margin of a central osteogenic sarcoma in lower portion of femur *PL* (Periosteal lippling) triangular area of new bone of periosteal origin due to elevation of *P* periosteum by *S* expanding extracortical portion of osteogenic sarcoma. *BD* Zone of invasion of periosteal lippling by tumor cells, with destruction of the periosteal bone *TB* Bone in tumor. Some of this bone is of periosteal origin and some of it is true tumor bone formed by the osteogenic activity of the tumor cells themselves *C* Cortex of femur *MC* Medullary cavity *MT* Intra-medullary portion of tumor containing bone of tumor cell origin and endosteal origin. $\times 24$

in place and ossified tumor *on top* of the periosteum

Chondrosarcomata of bone are the result of malignant degeneration of chondroblasts. Areas of new bone of tumor cell origin and calcified tumor cartilage are irregularly distributed within them. These represent maturation of certain portions of the tumor (6). When arising centrally these neoplasms may finally perforate the cortex and form large extracortical masses. Figure 15 is a roentgenogram of a slice of the upper portion of a tibia bearing a large chondrosarcoma. Irregular scattered masses of ossification and calcification are seen. In the inferior portion of the extra-cortical mass fine strands of bone radiating from the cortex are present. Gross and microscopic study showed that the periosteum was reflected over the tumor mass, having been elevated from the surface of the cortex. These fine radiating strands are composed of non-tumor bone having been laid down within and about the tumor by the periosteum as it was elevated and stimulated by the expansile growth of the tumor.

Fibrosarcomata of bone are osteolytic. When arising centrally they first destroy the

cortex and then by expansile growth elevate and later disintegrate the periosteum. Over such tumors the undestroyed elevated periosteum exhibits little or no osteogenic activity. If a few new bony trabeculae are laid down they are immediately attacked by eroding tumor cells and osteoclasts and are destroyed. Figure 16 is a microscopic section from the periphery of a fibrosarcoma arising in the upper portion of the tibia showing the beginning destruction of small bony trabeculae that were formed by the overlying elevated periosteum.

An interesting phase of the question is the factor or factors that govern the osteogenic activities of the periosteum when it is elevated by these neoplasms of various cell types. As was pointed out some of the neoplasms composed of malignant osteoblasts and some Ewing's sarcomata stimulate a high degree of periosteal new bone formation *within* them. Chondrosarcomata cause only a very limited amount of such new bone formation. Fibrosarcomata certain osteogenic sarcomata and some Ewing's sarcomata although elevating the periosteum extensively may stimulate very little or no new periosteal bone formation.

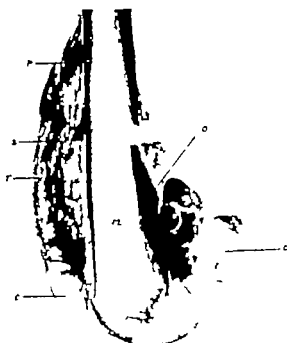


Fig. 1. Radiograph of slice of periosteal osteogenic sarcoma (malignant osteoblastoma) arising over lower portion of femur. *O* Area of periosteum or superficial region of cortex from which the neoplasm arose. *C* Large areas of cartilage with resorbing ossifications. *U* Medullary cavity free from neoplasm. *T* Portion of neoplasm that grew about shaft on top of periosteum and cortex. *P* Narrow clear zone between tumor and surface of cortex denoting the presence of periosteum that has not been elevated from cortex. *S* Area from which the microscopic section shown in Figure 14 was taken.

Not enough information is at hand to explain this relationship between these tumor cells and the osteoblastic activity of the periosteum and endosteum. Such new bone formation might be excited by mechanical disturbance as from elevation and stretching of periosteum by the expanding tumor. It might also be excited biochemically by substances of tumor cell origin. That the periosteum tends naturally to form new bone when simply elevated is shown by the fact that at margins of the extracortical portion of these tumors periosteal lippling is always present to some extent.

In conclusion, mention may be made of the recent work of Berg in which a filterable tumor producing agent was injected into the medullary cavities of the tibia in chickens. In the resulting neoplasms there were fine closely applied trabeculae of bone radiating



Fig. 4. Photomicrograph from area *S* in previous illustration. *T* Bone forming sarcoma. The bone of tumor cell origin has a very mature appearance in this region. *P* Periosteum lying on cortex in its natural position. *C* Cortex. *CB* Cancellous bone (bone marrow is present in some of the marrow spaces). $\times 435$.

from the surface of the cortex. A study of the illustrations accompanying this report shows that the bone is entirely of periosteal origin due to the elevation of this membrane by the expanding tumor as in the experiments described above and not due to osteoblastic properties of the tumor cells as inferred by this author.

SUMMARY AND CONCLUSIONS

1. A transplantable rat sarcoma originating in the abdominal wall the cells of which do not exhibit osteogenic properties was inoculated into the medullary cavity (and beneath the periosteum) of long bones. The neoplasm grew through and considerably beyond the cortex, elevated the periosteum and caused it to lay down new bone in the form of radiating trabeculae within the tumor.

2. Additional experimental evidence is also presented to show that all of the new bone in these tumors was periosteal in origin and not due to osteoblastic properties acquired by the tumor cells as a result of implantation within bone.

3. In osteogenic sarcomata (malignant osteoblastomata) in man elevation of the periosteum by the growing neoplasm may be an important contributing factor to new bone formation even though the tumor cells themselves also exhibit osteogenic properties.

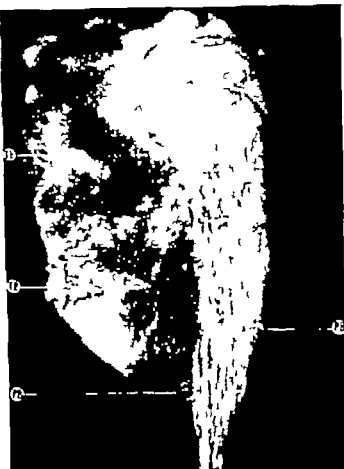


Fig 15 Roentgenogram of slice of chondrosarcoma arising in the upper portion of the tibia. *TB*, Scattered areas of tumor bone and calcification are present in the extracortical mass. *PB* Fine radiating strands of periosteal bone.



Fig 16 Photomicrograph of peripheral margin of fibrosarcoma arising in upper portion of tibia. *T* Tumor. *PB*, Trabeculae of periosteal bone formed by elevated periosteum. *P* These trabeculae are being destroyed by erosive action of tumor cells and by osteoclasts (*Osc*). *I* Invasion of tumor cells through the periosteum. $\times 70$.

4 In Ewing's sarcoma metastases to soft tissues do not ossify yet within the primary growth there may be strands of bone radiating from the cortex. All of this new bone is of periosteal origin being laid down as the tumor elevates this membrane by expansile growth. The mode of new bone formation in this type of neoplasm is quite analogous to that in the experimental tumors described. The onion layers of new bone in Ewing tumors are also of periosteal origin.

5 In the extracortical portions of chondrosarcoma fine spicules of bone radiating from the cortex may be present. These are of periosteal origin in contrast to the irregular areas of calcification and ossification that are scattered within the neoplasm and that are of tumor cell origin.

6 When periosteum is elevated over the osteolytic fibrosarcoma of bone its osteo-

genic properties are little if at all stimulated.

7 There is no apparent explanation for the variation in osteogenic activity on the part of the elevated periosteum which is seen in the several types of primary bone tumors which have been described unless this activity rests in the biochemical properties of the tumor cell.

BIBLIOGRAPHY

1. BRUNO, R. Experimental production of several varieties of bone sarcoma by intramedullary injections of the virus of the filterable fowl endothelioma tumor. *Am. J. Surg.* 1932; 15: 441.
2. BRUNSCHWIG, A. and HARMON, P. H. Studies in bone sarcoma. I. Malignant osteoblastomata as evidence for the existence of true osteoblasts. *Surg. Gynec. & Obst.* 1933, 57: 711.
3. Idem. Studies in bone sarcoma. II. Is new bone formation in osteogenic sarcoma due to supersaturation of tissue fluids with calcium. *Am. J. Cancer* 1934, 22: 342.

4. KOLODNY, A. Bone sarcoma: the primary malignant tumors of bone and the giant cell tumor. *Surg. Gynec. & Obst.* 1937 44: 1-110.
5. LERICHE, R. and POLICARD, A. Les problèmes de la physiologie normale et pathologique de l'os. Paris Masson, 1926.
6. PRINCETON, D. B. Chondrosarcoma of bone. *Surg. Gynec. & Obst.* 1930, 50: 216.
7. Idem. A study of ossification in bone sarcoma. *Radiology* 1926, 7: 17.
8. RIESER, H. *Geschwulstlehre fuer Aerzte und Studierende*. Bonn: Cohen, 1904.

LYCOPODIUM GRANULOMA¹

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By the term lycopodium granuloma is meant a granulomatous lesion developing in certain tissues after operation as the result of the introduction of lycopodium spores into the field of operation. Of recent years in many hospital operating rooms it has been the custom to use a dusting powder for gloves composed of a mixture of lycopodium spores and talcum powder; this is apparently an excellent preparation for the purpose. It is easily sterilized, keeps the gloves dry and serves as a lubricant so that they may easily be pulled over the hand.

Lycopodium powder consists merely of the spores of a species of club moss, *Lycopodium clavatum* which belongs to the fern family. While the plant is native to Europe, Asia, and America the spores for commercial purposes are collected chiefly in central Europe. The powder which has been called also vegetable sulphur is pale yellow, smooth, fine, very mobile, floating on water and not wetted by it, and burning with a quick flash when thrown into a flame. Talc is magnesium silicate which is rather an inert material. In powder form this has rather a soapy feel and is an excellent dusting powder and lubricant. The ease with which lycopodium spores gain entrance to the tissues during the course of an operation requires no explanation. In the cases here reported granulomatous lesions were found around lycopodium spores which had evidently been implanted in the tissues during previous surgical procedures.

The lesion is essentially a foreign body reaction to these spores; the spores themselves having been killed during the process of sterilization. It is composed of granulation tissue

arranged in the form of nodules about the foreign body. The older nodules bear a striking resemblance to tuberculosis, showing endothelial cells, multinucleated giant cells, varying degrees of fibrosis and lymphocytic infiltration with sometimes areas of necrosis or caseation. The spores may be found in the granulation tissue, the areas of necrosis or in giant cells. They are hollow spheroidal bodies measuring about 30 microns in diameter with scalloped or serrated margins and protruding from the surface are numerous spinous processes. When intact the outer surface presents a dimpled appearance not unlike that of a golf ball. On cross section they appear as a ring and contain a coarsely granular material. In hematoxylin and eosin sections they stain poorly; however with the Ziehl-Neelsen preparation they stain a brilliant red.

REPORT OF CASES

CASE 1: A R. male, aged 5 years, had suffered from chronic bronchitis and maxillary sinusitis for several years. He attended the out-patient department of the Hospital for Sick Children in 1932. In August of that year his antrum was irrigated repeatedly and on one occasion was injected with iodized poppy-seed oil. He returned about one year later with his symptoms persisting. In October, 1933, a radical antrum operation was performed and fragments of antral mucosa were sent to the laboratory for examination. The microscopic appearance of the lesion is shown in the accompanying photomicrographs. The general picture, as seen in Figure 1, is that of a conglomerate "tubercle" with fibrosis and peripheral lymphocytic infiltration. In the centers of the tubercles can be seen endothelial cells, multinucleated giant cells, and, in one instance, a small oval, pale staining granular spore. Figure 2 shows another "tubercle" with central caseation and one of the spores stained acid fast.



Fig. 1 Case 1 Maxillary antral mucosa hematoxylin and eosin X35

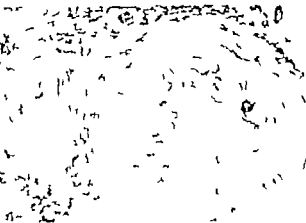


Fig. 2 Case 1 Ziehl-Neelsen followed by hematoxylin and eosin X105

The tissue in this case was examined some 14 months following previous surgical treatment at which time it would appear that the spores were introduced.

CASE 2 B B male, aged 9 years, was admitted to hospital December 8 1931 and died April, 26 1932 of cirrhosis of the liver of about 8 months duration 3 months following an exploratory laparotomy at which operation the liver was palpated. The lycopodium lesions, which were confined to the surface of the liver were not noticed at the time the sections were first studied, and it was only during a review of our cases of cirrhosis of the liver some months later that the true nature of these superficial lesions was recognized. The microscopic picture bears a striking resemblance to that seen in Case 1 (Figures 3, 4, 5).

CASE 3 This patient developed symptoms of intestinal obstruction 2½ years following appendectomy. A second laparotomy was performed by Dr D E Robertson, to whom I am indebted for the clinical notes and the biopsy material and with whose kind permission this case is being reported. Old adhesions were found at the site of the previous operation. These were severed and the symptoms relieved. During the operation several small, whitish nodules were seen studding the peritoneum in the iliocecal region. One of these was removed for section. Its microscopic structure is shown in Figure 6. While the general appearance is similar to that in the 2 previous cases, the fibrous tissue is more dense, and caseation is more extensive. This may be accounted for by the longer interval of time (2½ years) which had elapsed between the two operations.

CASE 4 W K male was first admitted to hospital November 25 1931 at the age of 10 years, for appendectomy. At that time the appendix which contained a number of pinworms, showed no evidence of acute or chronic inflammation and the boy made an uneventful recovery his temperature falling to normal 48 hours after operation. He was readmitted February 21 1934 with typical signs and symptoms of intestinal obstruction of about 24 hours duration. The abdomen was opened and the

obstruction was found to have occurred as the result of adhesions around the site of the previous operation. About 12 inches of small bowel was gangrenous. This was resected. Scattered over the peritoneum in the neighborhood of the adhesions were numerous small whitish nodules. One of these was removed and its microscopic structure is shown in Figures 7 and 8. Following the second operation the patient made an uneventful recovery.

CASE 5 A boy D L aged 7 years, died of a malignant endothelioma of the pleura. Because of pressure on the spinal cord resulting from invasion of the spinal canal by the tumor a laminectomy was performed. Five weeks later the boy died and examination of the tissues in the region of the operation revealed a granulomatous reaction with numerous foreign body giant cells, some tubercle formation and here and there the presence of lycopodium spores. In addition however to the spores there were also present small spicules of bone and what appeared to be the remains of suture material.

CASE 6 A S male, aged 12 years, died in the Hospital for Sick Children August 15 1933 of an abscess in the left frontal lobe. Two months before his death this abscess had been drained and a rubber drainage tube had been inserted. At autopsy the brain tissue immediately surrounding the tube bore little resemblance to cerebral cortex. There was proliferation of glia cells with some polymorphic infiltration. In addition there were quite numerous foreign body giant cells in which an occasional lycopodium spore could be found.

DIAGNOSIS

While as stated above these lesions bear a striking resemblance to tuberculosis, the essential feature in the diagnosis is the finding of the foreign body nucleus. To this end one must be familiar with the appearance of the spores. This, while quite characteristic as shown may readily go unrecognized on superficial examination as the spores stain

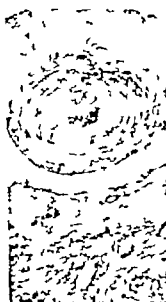


Fig. 3 Case 1 Lesion on surface of liver, hematerylin and eosin $\times 30$



Fig. 4 Case 1 An unstained spore can be seen in the center of the area of caseation, hematerylin and eosin $\times 30$



Fig. 5 Case 2 Zehl-Neehen, hematerylin and eosin $\times 300$

very poorly in routine hematerylin and eosin sections. In doubtful cases the acid fast stain should establish the diagnosis. Because of the striking resemblance to tuberculosis, one must not be led astray by the presence of caseation as this may be fairly extensive (Fig. 6). On the other hand it should be pointed out that the mere finding of a few lycopodium spores in a given section does not necessarily mean that they are the cause of the lesion. Because of their peculiar reticulated surface they readily adhere to any tissue so it is quite conceivable that biopsy material might become contaminated by spores from the surgeon's gloves at the time of its removal. In this case they might be found around the periphery of the tissue. In order to incriminate the spores as the causative factor in a given lesion they must be found within the giant cells, or at least within the nodules of the lesion. The question as to whether or not the tissue under investigation has been the site of a previous operation should also be borne in mind. Another important factor is the locality of the lesion; for example, tuberculosis of the antrum would be extremely rare without evidence of clinical tuberculosis in other parts of the body.

LITERATURE

The literature on the subject of foreign bodies in general is rather extensive. The reaction in the surrounding tissues apparently varies with the nature of the tissue and with the size, shape and chemical composition of the bodies themselves. Under the title of "Nodular Lesions of Peritoneum" Haythorn recently reported a series of nearly 30 cases chiefly foreign body granulomata due to animal parasites, extravasated blood, gelatinous substances, oils and free fats, extruded stomach and intestinal contents and extraneous foreign bodies. Under the latter group he includes sutures, threads, bits of sponge and so on, but while his article is very comprehensive only four lines are devoted to this group in which no reference is made to lycopodium. The same appears to be true of all the other articles dealing with foreign body lesions, with the exception of a recent article by Antopol. He reports 6 cases and refers to 2 others; his photomicrographs show lesions almost identical with those reproduced here. He also mentions that similar lesions may be produced by talc crystals. Thus far we have not encountered any such in human material.



Fig 6 Photomicrograph in Case 3. Ziehl-Neelsen, hematoxylin and eosin X50

DIFFERENTIAL DIAGNOSIS

It is my purpose to draw attention to a type of lesion the significance of which in the past has no doubt frequently been unrecognized.

Lycopodium powder has been used in the past to produce foreign body granulomata in experimental animals. This being the case one need not be surprised if such lesions develop in the human body after their accidental introduction into the field of operation.

As the title might suggest that one is dealing with some sort of fungus disease, it should probably be emphasized here that the reaction is essentially a foreign body one the spores having been killed by sterilization previous to introduction into the tissues. That it is only a foreign body reaction however is another matter. The fact that the spores are acid fast, as are also tubercle bacilli and that the lesions produced by the spores are almost identical with tubercles even to the production of caseation leads me to believe that the chemical composition of the spores may be an important factor in determining the type of reaction. According to the United States Dispensary lycopodium spores contain "48.5 per cent of a neutral non-drying oil, very similar to almond oil. This oil contains 2 per cent of a fatty acid called lycopodic acid ($C_{18}H_{34}O_2$) 80 per cent of oleic acid, a minute quantity of a vegetable cholesterol similar to that obtained by Heise from Calabar beans 8.2 per cent of glycerin and 3 per cent of arachidic, palmitic and stearic acids." It is no doubt this oily structure of the spores that causes them to burn with such a rapid and bright flash when thrown into a flame. That such a chemical composition should in

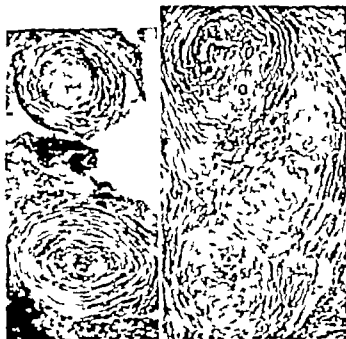


Fig 7 left Case 4. Hematoxylin and eosin X90.

Fig 8 Case 4. Three spores can be seen in the upper half of the field. Ziehl-Neelsen hematoxylin and eosin X90.

fluence the type of reaction is more than probable. This view would seem to be supported by recent experimental work of Gardner and Cummings, working with silica and aluminum oxide. By intravenous injection into rabbits of fine particles of both these substances these investigators were able to produce a "typical hyaline nodular silicotic fibrosis of the liver by means of silica while the same sized particles of aluminum oxide were merely phagocytosed and produced no fibrosis. They conclude their article in the following words: "These observations support the viewpoint that the injury produced by silica is specific and chemical rather than physical in character." The same I believe is true of lycopodium spores.

While lycopodium spores are obviously capable of producing lesions in the tissues such lesions are not to be regarded as necessarily injurious to the patient. Of the 6 cases here reported in 3 (i.e. Cases 2, 5, and 6) the course of the disease was probably in no way modified by the presence of lycopodium granulomata. The same, however, can hardly be said of the 3 other cases. In Case 1 it is quite possible that the presence of the spores in the antral mucosa may have produced an aggravation of symptoms. When one recalls that the an

trum of a 5 year old child is, at best quite small anything that tends to produce a thickening of the mucosa might conceivably interfere with adequate drainage from the antrum. It is also conceivable that if spores were present in the wall of a discharging sinus, they might tend to cause persistence of symptoms. Cases 3 and 4 were similar in that both developed intestinal obstruction some 2 years after a previous appendectomy. That the adhesions which gave rise to the obstruction were caused in whole or in part by the lycopodium spores is difficult to determine. In Case 4 particularly the gross and microscopic appearance of the appendix and the post-operative course on the first admission would lead one to believe that had no spores been introduced there would have been no cause for adhesions to develop. Following the discovery of this case the use of lycopodium spores in dusting powder in this hospital was discontinued. In the last 2 cases reported the lesions found cannot be considered as due solely to the lycopodium spores. In Case 5 while spores were found in the granuloma at the site of operation other foreign bodies in the shape of chips of bone and suture material were also present. In Case 6 no spores could be seen in the field showing the greatest foreign body reaction their presence however within the tissues served to illustrate the ease with which they may be introduced into the field of operation.

Thus, while the presence of the spores in some instances may give rise to little or no

inconvenience to the patient they may lead to serious errors in diagnosis which may result in radical or unnecessary surgery. Antopol reports the case of a man who was admitted to hospital because of a persistent sinus and mass in the epididymis. He gave a history of operation for traumatic hydrocele 2 months previously. A clinical diagnosis of tuberculous hydrocele was made and an orchidectomy was performed. Microscopic examination proved the lesion to be a lycopodium granuloma.

SUMMARY

Six cases of lycopodium granuloma are here reported in which the spores were obviously introduced into the tissues during some previous operative procedures. In 4 of these cases the resulting lesions bore a striking resemblance to tuberculosis with which they might easily be confused.

Two of the patients developed intestinal obstruction from adhesions at the site of a previous operation and there is reason to believe that these were caused by the lycopodium spores. In the opinion of the author the use of lycopodium spores as a dusting powder in operating rooms should be discontinued.

REFERENCES

- ANTOPOL, WILLIAM. Lycopodium granuloma. Arch Path 933, 16, 326.
- GARDNER, LEROY U. and CUMMINGS, DONALD F. The reaction to fine and medium sized quartz and aluminum oxide particles. Silicotic cirrhosis of the liver. Am J Path 1933, 9, 751.
- HAYTHORN, SAMUEL R. Nodular lesions of the peritoneum. Am J Path 1933, 9, 725.

FACTORS CAUSING DELAY IN OPERATIVE THERAPY OF CARCINOMA¹FREDERICK M. SMITH M.D., New York
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THIS study was based upon interviews with 95 patients. This is perhaps a small number from which to draw conclusions yet each case has been investigated personally by the author. All of the patients with 3 exceptions were admitted to the surgical wards of the Presbyterian Hospital in New York City. Of the 3 exceptions 1 was a private patient and the 2 remaining were seen in the Out Patient Department of the Vanderbilt Clinic. In all of the 95 cases a complete history and physical examination had been recorded upon the patient's chart. They were collected during a period of slightly more than 1½ years from October, 1929 to June 1931.

Practically every group of cancer patients studied shows a marked period of delay between the onset of symptoms and the time that they obtain proper treatment. It is the purpose of this study to determine what are the chief factors causing this delay. It is generally considered that cancer in its beginnings is a localized growth. Whether this be absolutely true or not makes no great difference. It is true that in many and possibly even in the majority of cases the growth remains localized for a brief period of time. This is one of the peculiarities of cancerous tissue that gives us some ray of hope, namely that we may possibly be able to eradicate the entire malignant tumor before any metastases have taken place. Without this hope there would be very little to look forward to in the treatment of cancer except the use of surgery or radiotherapy solely for palliative measures.

Simmons and Daland in Boston analyzed the cases of malignancy of all kinds entering the Massachusetts General Hospital from 1917-1918 and 1921-1922 and found that there was an average of 12.5 months and 11.6 months respectively between the onset of symptoms and the appearance of the patient at the hospital. In the breast cases alone there was an average delay of 11.4 months and 12.4 months respectively which is

slightly greater than that found in the group of breast cases considered in this paper. J. M. Wainwright speaking on the reduction of cancer mortality states that the Pennsylvania Cancer Commission showed that 'in superficial cancers while the patient himself was aware of his condition for 1 year and 2 months the physician also had that knowledge for an average of 1 year. In deep-seated cancers the patient knew of the condition for 18 months and the physician knew of it for 13 months. Such delays are not limited to the State of Pennsylvania but have been and still are prevalent in every state in the country.

To return to the causes of delay, we may ask: What is to be considered as proper treatment? The answer is that proper surgical treatment in cases of malignant disease where surgery is applicable is *radical treatment*. In other words cancer is a deadly disease if untreated, if maltreated, or if given the correct type but inadequate amount of treatment. I mean by this that there are many patients that might have been saved had they been seen early and given radical treatment at the start.

The causes of delay in any group of cancer patients receiving what may be considered proper and adequate treatment are many but these may be classed under four main headings: ignorance or carelessness, fear, expense and lack of symptoms and disability. *Ignorance* may be blamed upon the patient himself upon his family, relatives or friends, and upon his local physician or the physicians seen in hospitals or clinics. *Fear* may be that of the patient toward the disease or toward the possibility of an operation. Fear of a member of the patient's family for the patient may in rare instances cause considerable delay. The *expense* of examination or of treatment (including operation) may keep a patient from consulting a doctor or from entering a hospital. The *lack of symptoms and of disability* is seen in a great many cases as a cause for

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delay. Much of this delay is the result of lack of serious symptoms or lack of pain. How many times have we heard a patient when questioned concerning his duration of symptoms, remark, "It never bothered me so I didn't think it serious and paid no attention to it." More will be said about these causes of delay farther on.

The 95 cases were as follows: Carcinoma of the female breast 41 cases; carcinoma of the rectum 19 cases; carcinoma of the sigmoid colon or splenic flexure 10 cases; carcinoma of the stomach 8 cases; carcinoma of the cecum 6 cases; squamous cell epithelioma of the oral cavity 5 cases; and a miscellaneous group of 6 cases. This miscellaneous group consisted of one squamous cell epithelioma of the lateral neck region, one squamous cell epithelioma of the auricle, one carcinoma of the esophagus, one sarcoma of the gastrocnemius muscle, one melanoma of the eye and one angio-endothelioma of the thigh. Each one of these cases was considered malignant upon pathological examination except the first case which was obviously clinically a far advanced carcinoma of the breast.

The time lost since the onset of symptoms varied from 4 days in 1 case to 7 years in another. Where the time between the onset of symptoms and admission to this hospital was 2 weeks or less, it is fair to assume that such a short time cannot be considered as any real delay. There were only 4 such cases in this group. There were 2 other cases with a duration of symptoms of only 3 weeks and 2 more with a duration of only 4 weeks. The average duration of symptoms for the whole group was 11.6 months. This latter figure is identical with that found by Simmons and Daland for the year 1921-1922. If our figures are at all comparable it shows that there has been no appreciable improvement in lessening the pre-operative duration of symptoms in cancer patients.

ANALYSIS OF GROUPS

A. Breast carcinoma. Of the 41 cases of carcinoma of the breast (all females) 25 had previously consulted physicians before coming to this clinic. Fourteen cases had consulted but one physician, 6 had consulted two physicians,

2 had consulted three physicians and 1 had consulted twelve physicians. Twenty three of this group of 25 patients had a definite palpable mass that had been noticed subjectively; 12 had some pain, 2 had consulted nurses in respect to the lump and 2 had sought treatment from a druggist without relief. Six had received definite bad advice or only local treatment from physicians outside. Eight patients were definitely delayed by carelessness or ignorance of the physicians examining them before they came here. There were 3 such cases in our own hospital. One was a patient examined and treated in the outpatient clinic for dyspnea and in whom the lump was noted in the breast on physical examination. No diagnosis was recorded in the chart and the patient was never referred to the surgical department. She then disappeared for 15 months to return with a hopelessly inoperable carcinoma with local and distant metastases.

The second case was examined in the outpatient clinic and the lump in her breast was considered benign. She was not seen by an attending surgeon on the day of her examination due to some error and there resulted an extra delay of 4½ months before she was finally admitted for operation. The third case may or may not have been treated earlier as she had noted a lump in her breast for only 5 months. It is interesting to note that 9 months previously she had had her heart and lungs examined in the emergency ward prior to taking a general anesthetic for treatment of an injury. One month later she was admitted to the hospital for an operation on her eye. On neither of these occasions was any note made by the examining physician in respect to her breasts.

Nineteen of the 41 patients may be partially or wholly to blame for their own delay either from ignorance or procrastination. There were 16 patients with breast cancer who had not consulted a physician before coming here. Each of these had a mass that she had noted herself. Twelve had had some pain referable to the breast or arm. In 15 the patient's own ignorance was largely the cause for her delaying consultation and treatment.

Nine patients of the entire 41 gave fear of the expense as a reason for their delays. 5 of

them gave this as their chief reason. Fifteen stated that fear of an operation was one of their reasons for delaying, 6 gave this as their chief reason. One patient, who had had a local removal elsewhere gave the fear of a second operation as her chief reason for delaying further treatment after she had had a local recurrence of the tumor. None of these breast cases had any real disability attributable to the breast condition. In all but 2 the symptoms noted by the patients were considered mild, and hence they put off seeking medical advice for many months. Only 2 patients stayed away for fear that they might have a cancer.

In these cases of breast cancer there was an average delay of 10 months between the onset of symptoms and the time the patient was admitted for operation (see Table I). There was an average delay of 3.2 months between the onset of symptoms and the time the patient first consulted her own doctor. The time lost between the first consultation with her doctor and the time she was admitted to this hospital for operation was 8.6 months on the average. The average delay from onset of symptoms when no outside doctor was consulted was somewhat less, namely, 7.3 months. This average delay is altogether too long if we hope to do any real good for the patients afflicted with breast carcinoma. It may be argued that some patients who consult a surgeon regarding a breast lump and have a radical operation for the same done within 1 or 2 weeks do not necessarily turn out to live the longest in the end. Some of these no doubt have extensive metastases in their axillary lymph glands or elsewhere at the time the lump is first noted in the breast. Of course if such be the case, the chances for a long cure following operation are small. However many of these patients do not have early metastases and again some patients who have had a known lump in the breast for a considerable period of time varying from many months to sometimes a year or longer still do not have axillary metastases at the time of operation. If this average delay could be cut down let us say 30 to 50 per cent there would unquestionably be a much larger number of 5 and 10 year arrests as a result.

TABLE I

Site	Number of cases	Average delay when no outside physician was consulted	Average delay between onset of symptoms and first consultation with a physician	Average delay between first consultation with a physician and operation	Average delay between first cancer symptoms and operation
Breast	41	7.3 mos	3.2 mos	8.7 mos	10.0 mos
Rectum	19	7.0 mos	4.8 mos	4.7 mos	9.1 mos
Sigmoid	10	7 days (1 case)	3.4 mos	3 mos	6.5 mos
Stomach	8	2.0 mos (1 case)	9 mos	6.6 mos	8 mos
Cervix	6	2.0 mos	3.1 mos	8.6 mos	3.3 mos
Oral cavity	5	12 mos (1 case)	8 mos	9 mos	10.2 mos
Miscellaneous	6	(Not included here as a group)			

This does not of course apply solely to breast cancers but is applicable to other types as well.

B Rectal carcinoma. Of the 19 cases of carcinoma of the rectum 17 had consulted one or more outside doctors or clinics more than half of them had consulted two or more physicians. The patient's own ignorance in 15 cases was definitely responsible in part for the delay in obtaining proper operative therapy. Two gave fear of an operation as the chief reason for delaying and 2 more gave this as a contributing factor. Two likewise stated that fear of the expense was their chief reason for delay and 2 more gave this as a contributing factor. Nine patients (or more than half of the total number of the 17 who had consulted physicians) were treated symptomatically without having had a rectal (digital) examination made upon them. This is a deplorable state when such patients are complaining of symptoms referable in the greater majority of instances to the lower bowel. One such case occurred in our own out patient clinic. She had been examined and had been followed there for 10 months with increasing constipation as one of her complaints. The tumor in her rectum was only discovered at the end of this time when she was finally referred for surgical consultation and the first rectal examination was made and the tumor easily palpated. Another case in the hospital had

been proctoscoped and the mass in his rectum biopsied. Clinically at proctoscopic examination the mass had the typical picture of a carcinoma. The biopsy specimen was sent to the laboratory where it was diagnosed in correctly as a benign polyp. The patient was allowed to go home but his symptoms became more severe. He was finally readmitted 3 months later with a mass in his rectum that had increased to about three times its original size. Another biopsy specimen examined in the same laboratory was again diagnosed as benign polyp. A similar piece examined by another laboratory was diagnosed carcinoma. The patient was operated upon and an infiltrating carcinoma was found which had involved the adjacent lymph glands.

One patient was seen by three outside physicians none of whom had performed a rectal examination. The first of these was an insurance company physician who when asked by the patient what to do for his increasing constipation advised him to take mineral oil. He did no rectal examination although he was examining a patient who was taking out a life insurance policy. Another patient had been seen by five outside physicians all of whom she stated were specialists. One of these advised and performed a hemorrhoidectomy upon her without having done a proctoscopic examination. She was naturally not relieved of her condition but was caused an unnecessary delay of 8 months.

Space does not permit going into each case individually but these just cited may help to show what is happening in a relatively large percentage. Six of the 9 cases which had received no rectal digital examination had easily palpable tumors. The 3 others had tumors that were discovered without difficulty when proctoscoped in this hospital. Of the nine, 8 had symptoms that called for a rectal (digital) examination and the ninth had suggestive symptoms.

Lack of symptoms and lack of disability were of considerable importance in the delay of these rectal cases. In spite of this fact many of these patients had a number of symptoms such as pain constipation or diarrhea bleeding per rectum etc. they also had had a

definite change in their bowel habits which might have made them suspect something more than hemorrhoids or colitis. There was only one patient of the 19 who really had severe symptoms and was actually disabled by her condition. One other patient was prevented from having an operation by his private physician and his wife even after carcinoma of the rectum had been confirmed both by proctoscopic examination and biopsy in our clinic.

In these rectal cases there was an average delay of 9 1 months between the onset of the patient's symptoms and his admission to the hospital for operation. The time lost between the onset of symptoms and the first physician consulted averaged 4 8 months. That between his first consultation and his admission here for operation averaged 4 7 months. Only 2 patients came to the hospital who had seen no outside physicians. The duration of their symptoms was 2 months and 12 months, respectively.

C. Carcinoma of the sigmoid colon. Ten patients were studied with carcinoma of the sigmoid colon (in which is included 1 case of carcinoma of the splenic flexure). Nine of these consulted one or more outside physicians. Five had definitely received bad advice or treatment by these local physicians. In 8 of these cases the delay may be attributed in part to the patient's own ignorance either in not consulting a physician sooner or in not asking for a more complete examination with the assistance of X rays. One patient stated that fear of an operation was his chief reason for delay. Two others attributed the fear of an operation as one of their reasons for delay. In only one of this group was fear of the cost of treatment responsible for the patient's delay. More than half of all these patients had symptoms of constipation diarrhea, or bleeding per rectum which really called for X ray diagnosis by the adjunct of the barium enema. The X ray is not always conclusive as proved to be the case with one patient followed in our own hospital and clinic for 8 months before repeated X ray examinations finally showed an obstruction in the sigmoid colon. The one case not seen by any outside doctors came to the hospital with symptoms

of complete obstruction for 7 days. On repeated questioning he stated that he had never had any symptoms prior to this attack of pain and obstipation. Two patients had been observed at other hospitals in New York City, but when advised to have exploratory operations they refused because the diagnosis was not considered certain. It is only natural not to accept an exploratory operation on an uncertain diagnosis, but had the necessity for exploration been impressed more firmly on the patient, he might have accepted it sooner.

One case in this group with symptoms of 7 years' duration had multiple polyposis of the colon and rectum and carcinoma of the sigmoid colon. It is hardly conceivable that operation for the polyposis at the onset would have cured him or prevented him from getting more polyps which might develop into carcinoma at a later date. For this reason this one case is omitted in calculating the statistics on delay in this group. The average duration of symptoms was 6.5 months. The average delay between onset and the first consultation with a physician was 3.4 months. The average delay between the first consultation and admission for operation at this hospital was 3.2 months. Early obstructive symptoms in these cases seem to account for the shorter delay as compared to the cases of rectal carcinoma. Lack of symptoms as well as only partial disability played a greater part in these delays than they did in either the breast or rectal cancers.

D. Carcinoma of the stomach. Although a small group this collection of 8 cases shows many pathetic instances in which early diagnosis and operation might have prolonged the patient's life very considerably and most of all would have relieved his symptoms for many months. There were 6 of these who put off seeing physicians early or who kept putting off an exploratory operation until very late. Only one patient attributed his delay in part to the fear of expense. None actually stated that the fear of the operation itself made him delay in seeking and obtaining adequate treatment.

Only one patient had not consulted an outside physician. His own family physician had

died, and he stated that he had no faith in any other. Consequently, he undertook to treat his increasing indigestion himself, as he did not think his condition at all serious. Of the 7 remaining, 5 were definitely given bad advice and treatment by outside physicians. Of the 2 others, both had been followed and treated in our own clinic or hospital. The first, a 60 year old woman, with digestive disturbances had been followed for 3½ years in the out patient clinic. Her symptoms and signs were indefinite, the X ray findings negative, and it was deemed inadvisable to operate with so little evidence pointing to a definite lesion. At the end of this time, a final X ray showed "two ulcers of the stomach" and the patient was finally admitted for operation. Such a delay cannot be attributable to lack of keenness on the part of the physicians for she was seen frequently during this period and nothing positive could be found until very late. It is also unlikely that this patient's symptoms were due to a carcinoma for 3½ years. An ulcer was most probably the original lesion but unfortunately this could not be demonstrated at a time when operative therapy had much to offer.

The second patient, a 56 year old man, came to the hospital complaining of an inguinal hernia. At the time of his admission he had some vague gastric symptoms for which a gastro-intestinal X ray examination was done which showed an "ulcer." He was then explored. A mass was felt in the pyloric end of his stomach which was thought by the operator to be "carcinoma or ulcer induration." One firm lymph gland was also felt near the pylorus. No biopsy was taken. A gastro-enterostomy, entero-enterostomy and appendectomy were then done. The patient finally returned 5 months later with symptoms of obstruction. At this time a second exploratory operation revealed metastatic nodules of tumor tissue scattered all over the peritoneum and a large mass in the stomach. No one can be dogmatic about the prognosis in individual cases, but it seems highly probable that this patient might have been greatly benefited by resection of the pyloric portion of the stomach at first operation had the operator not taken the chance of its being "ulcer induration."

Disregarding the one case of $3\frac{1}{2}$ years duration the average delay in these gastric cases was 8.1 months from onset of the symptoms to admission to the hospital. The average delay between onset of symptoms and the first consultation with a physician was 2.9 months. The delay between the first consultation and admission here for operation averaged 6.6 months. With very few exceptions, all these patients showed symptoms that were moderate or mild and none showed any real disability. Cancers of the stomach like cancers elsewhere show an insidious onset which explains the great delay in these patients seeking early treatment. Being so called internal cancer it is not easy to see how much improvement will take place in hastening these cases to get early diagnosis and adequate operative treatment.

E. Carcinoma of the caecum. Again this is a small group of cases (six) but each one delayed seeing a physician or refused what was considered adequate treatment when prescribed by a physician. Two had seen no physicians outside of this institution. Three were given definite bad advice or treatment by the physicians consulted. One was treated by her physician for pernicious anemia for 2 years. When she did not improve he advised having intestinal X-ray pictures taken on several occasions but his hands were tied by the patient who refused these on account of the expense. The fault in this case was not entirely his, as he presumably was considering the patient's finances. On the other hand, it unquestionably cost the patient more in the end, and had he insisted on the X-rays, he not only would have saved her money but would have been able to establish the diagnosis much earlier. One other patient in this group gave the fear of cost of treatment as her chief reason for delay. Another attributed the fear of an operation as a contributing reason for her delay.

The total average delay from onset of symptoms to admission to the hospital in these cases of carcinoma of the caecum was 13.3 months. The average delay from onset of symptoms to the first consultation with a private physician was 5.3 months. From this first consultation to admission for operation

in this hospital the average delay was 8.6 months. The 2 patients seeing no physicians prior to coming to the hospital each showed a duration of symptoms of 12 months. The delay in these cases is naturally longer than in those having carcinoma of the sigmoid. This is due largely to the different physiology of this portion of the bowel where fluid feces easily pass until the obstructing lesion becomes very marked. Other clinics have noted similar findings.

In only 3 of the 6 cases were symptoms shown that might be considered mild and their mildness acted as a contributing factor in their delay. None of the 6 showed any real disability.

F. Squamous-cell epithelioma of the oral cavity. There were 5 patients in this group. One had been in this hospital a year previously but her tongue at that time was giving her no trouble. She noticed nothing until after she had left the hospital and then did not consult a private physician or come back to have her tongue examined in the hospital until after nearly 1 year when she then had a definite epithelioma. This patient gives her sole reason for delay as being due to fear of the expense. Of the 4 remaining patients 2 had seen at least 2 physicians and dentists and 2 had seen at least 3. Two may blame their delay to a considerable extent to their own ignorance. One of these consulted a druggist and received treatment from him for several months before seeing a physician. All 4 were definitely given bad advice and treatment by the dentists and physicians they consulted. Of these 1 was treated with local applications for 7 or 8 months on a diagnosis of Vincent's angina, while the lesion which had first healed reappeared and became progressively worse under treatment. No biopsy had been taken. The second was treated with a small dose of radium in another hospital without a biopsy having been taken. He then went to a second hospital where a biopsy was taken and the patient referred to this institution. It might be argued that X-ray or radium was the proper treatment in this case. Even if this be conceded the dosage was most likely inadequate and in addition was not based on microscopic examination of a biopsy specimen. The

third case was seen by several dentists. He had three biopsies taken, the first two of which showed "benign papilloma" the third was lost. Finally after 10 months when an X ray picture showed an "infectious process in the mandible" the patient was referred to this hospital. The fourth case had a local removal 1 year previously by an oral surgeon, following which he was given either X ray or ultra violet light treatment. The lesion finally recurred 4 months later, but the patient put off going to see his dentist again for 3 more months. The latter then sent him to this hospital.

The average time lost in these cases between the onset of symptoms and admission to this hospital for operation was 10.2 months. All of the patients, with one exception, consulted a dentist or a physician within 2 months or less after the onset of the first symptom. The average delay between the first consultation with a dentist or a physician and admission to this institution for operation was exactly 9 months in the 4 cases that had sought any medical advice outside. Four of the 5 patients had little or no symptoms and no disability. This may account for some, but not all of their delay. The fifth patient had much pain and also disability. He sought treatment early and persistently. He, however, was the one who had had two "negative" biopsies and a third one that was lost and was only referred to us after 10 months of local treatment.

G Miscellaneous cases Since each case in this group is of a different type it is felt that a brief summary of the individual case would be better than trying to sum them up as a whole. It will thus be seen more clearly where the delay took place and to whom it may be attributed. The first case, a 33 year old woman, had a tumor in her neck for 2 years. She went for 18 months without consulting a physician. A friend had told her it was an "enlarged gland" and was of no significance. Finally when she consulted a physician he gave her "injections" for 3 months without relief. The tumor turned out to be a squamous cell epithelioma of the lateral neck region (the growth probably arising from a branchiogenic rest).

The second case was that of a 37 year old woman with a tumor of her lower thigh of 3 years' duration. She had been treated by four private physicians without a diagnosis having been made, and without relief. She was afraid an operation might be necessary and for this reason stayed away from hospitals and clinics. At last a friend told her she might have a tumor and advised her to see another physician. This she did (at the end of 3 years) and was referred to this hospital. Her tumor turned out to be an angio-endothelioma.

The third case a 55 year old man, who had suffered for 7 months with difficulty in swallowing and a loss of over 60 pounds in weight, consulted no physicians outside of this hospital because he "did not think his condition amounted to anything" and because he was afraid of the expense. He turned out to have a carcinoma of the esophagus. There may be some doubt about early treatment being of benefit in this case, but it shows how a patient can neglect himself in spite of marked symptoms.

The fourth case, a 71 year old man, came to the hospital complaining of double vision, occasional pain and bulging of his right eyeball. The double vision had been present for 3 years. He saw a physician shortly after the onset who treated the condition with eye-drops without relief. Later he consulted an eye clinic where he was likewise treated with eye-drops. One physician at this clinic had suggested an operation but the patient states that "this never came to a final decision." He later saw three other physicians in turn and each of these treated his eye with drops. Following this he went to another hospital where a small dose of radium was given without relief. Finally at the end of 3 years, when his eye began to bulge, his daughter insisted on his coming to this hospital. His condition was due to a malignant melanoma that had broken through the sclera and had invaded the posterior part of the orbit, thus forcing the globe forward. Although the patient had paid little attention to his condition, even though it did not improve, a careful ophthalmoscopic examination early would probably have clinched the diagnosis and led to early adequate treat-

TABLE II—PERCENTAGE SURVIVAL RATE OF CANCERS WITH AND WITHOUT AXILLARY METASTASES AT OPERATION (AFTER STOUT)

	Three years postoperative		Five years postoperative	
	Alive	Apparently cancer-free	Alive	Apparently cancer-free
N metastases	63	47.5	54	46
All cases	45.9	3	3.3	1.3
Metastases	38.9	14.5	3	3

ment. The majority of the physicians seen by the patient were general practitioners who had merely made very superficial examinations of the eye and then proceeded to treat it symptomatically.

The fifth case a 33 year old woman consulted a physician 14 months previously for pain and cramps in the calf of her leg. He treated her for fallen arches, but the pain persisted though not severe. One year later she consulted another physician because the calf of the leg had become swollen. This physician incised the swelling in the belief that she had an abscess but found no pus. He took no biopsy and told the patient that he had found nothing suspicious. When she came to us a microscopic section showed a reticulum-cell sarcoma of the gastrocnemius muscle for which amputation was done.

The last case was that of a 56 year old man with a squamous cell epithelioma of the auricle which he had had for 2 years. He treated it himself for 6 months without success. He then consulted a physician who spent 12 months more treating it with salves and lotions but without success. At last the physician took the patient to a specialist who immediately referred him to this hospital.

SUMMARY

The lack of symptoms and the lack of disability play by far the greatest rôle in delaying cancer patients in seeking and obtaining what is considered proper and adequate treatment. Many of these patients have perfectly definite symptoms of their disease but it is a lack of severe symptoms or a lack of real disability that makes them not complain. This is the one characteristic of cancer particularly in its early stages, that seems to be

the bugbear of the medical profession in shortening the delay in these patients getting early treatment. As long as cancer rarely gives marked pain or other pronounced symptoms in an early stage it will remain particularly difficult to get patients to seek earlier consultation unless more impressive propaganda is distributed to the lay public. Two patients only in this group came to the hospital because of hearing or reading about cancer symptoms. Both were breast cases. One after attending a lecture on cancer came to the clinic for advice concerning a lump she had had in her breast for 30 months. The second with a lump in her breast of 3 years' duration had consulted twelve physicians, but had been reassured by each in turn that the lump was of no importance. She finally read several articles in the newspaper and then came to the clinic.

The more specific causes for the delay in these 95 cases may be attributed to the patient's own ignorance of such conditions in 33 instances. In 19 cases it may be attributed to the patient and the physician combined. In 18 cases it may be attributed to the physician alone, and 5 of these were the fault of carelessness or ignorance of the physicians in this institution. This is but a small portion of the total yet these mistakes might easily have been averted had a little more care been taken. It is easy enough to blame outside physicians for failure to recognize or treat a cancer properly when the case finally comes to a large hospital with all its personnel and diagnostic facilities but it is regrettable when a similar inability to make a correct diagnosis (and especially in some fairly obvious cases) is due not so much to ignorance or stupidity of the physicians in a large hospital or medical center but to carelessness on the part of these physicians in failing to do a rectal examination in a case of rectal carcinoma or when the volume of clinic routine and red tape cloud or delay the issue with resultant delay in the patient receiving a thorough and careful examination and early operation.

There were only 11 patients in the total number who gave the fear of cost of treatment as their chief reason for delay. Another group of 10 patients stated that the fear of an opera-

tion was their chief reason for not seeking relief at an earlier date. Only 2 patients in the whole group stated that they delayed because of the fear they might have a cancer.

The average lost time for all these patients studied was exactly 11.6 months. The author has attempted to estimate roughly the amount of delay that might have been avoided in each case. This estimated *avoidable* delay was approximately 7.6 months on the average. If it were only possible to eliminate this *avoidable* delay it would mean that these patients would come to the hospital with an average *unavoidable* delay of only 4 months. It is interesting to speculate on the increased number of operable cases could they be obtained with such a short duration of symptoms.

There is a very striking difference in the results of various cancers treated before and after lymph node involvement has taken place. To mention the group of breast cancers alone, I could do no better than to quote Stout and reproduce the table in his book on *Human Cancer*. In a detailed analysis of all types of cancer operated upon at the Presbyterian Hospital for the ten year period of 1916-1925, inclusive he states that "there were metastases in 53 per cent of those cancers radically removed 1 month or less after discovery and if one year or more had elapsed between discovery and operation we found that 73 per cent showed axillary metastases and 85 per cent later died of generalization."

Stout also states that "if axillary nodes are involved at the time of operation it is an indication that the woman has less than one chance in eight of having had all the cancer removed by the operation for only 12.3 per cent were cancer free after 5 years. Conversely, if there are no axillary metastases found at the time of operation more than one half the cases will survive more than 5 years and nearly one half the cases will be cancer free at that time."

CONCLUSIONS

In conclusion it might be well to repeat that the average total duration of symptoms in this series was 11.6 months a figure identical with that found by Simmons and Daland, and nearly the same as that found in a study

by Farr, namely, 11.9 months. Although it was the purpose of this study to determine the factors causing this delay these factors in themselves would suggest a partial solution for shortening this delay. The fault was found to belong to the patient, the physician, or a combination of both in 70 cases in this series, or approximately 74 per cent of the whole group. It would seem, therefore, that anti-cancer propaganda for the lay public must be made much more effective if we are to expect patients to seek medical advice at an early date. On the other hand, this will be of no avail, unless even more strenuous propaganda be carried out within the medical profession in order to get the general practitioner to suspect cancer more frequently and to refer the suspected case to a surgeon or hospital well qualified to diagnose and treat cancer. When the *avoidable* delay can be cut down from one half to two-thirds of its present length, then only shall we be able to expect a real improvement in the treatment of patients afflicted with cancer.

REFERENCES

1. AUCHINCLOSS H. How more women can be saved from dying of cancer of the breast. *Med. J. & Rec.*, 1929 130 446.
2. BLOOMGOOD J. C. The responsibility of the medical profession for cancer education. *Am. J. Cancer*, 1931 15 1577.
3. CLARK, J. G. Report of the committee on cancer of the uterus. *J. Am. M. Ass.*, 1906 47 1867.
4. FARR, C. E. Delay in the treatment of cancer. *Am. J. M. Sc.*, 1922, 124 712.
5. Idem. Delay in the treatment of cancer. *Am. J. M. Sc.*, 1929 157 34.
6. GIBSON C. L. Cancer surgery. *Am. J. Surg.*, 1915 29 374.
7. GORMICK, P. *Muenchen med. Wchnschr.* 1929 29 1502.
8. LEWIS, DEAN. Some surgical aspects of the cancer problem. *Am. J. Cancer*, 1931, 15 4.
9. MANORA, M. The general practitioner's responsibility in early diagnosis of cancer. *Am. J. Surg.*, 1915 29 377.
10. RECTOR F. L. Present-day cancer problems. *J. Am. M. Ass.*, 1933 101 672.
11. REIDMAN S. P. and SAFFORD F. H. The avoidable delay in the treatment of carcinoma. *Am. J. Cancer*, 1931 15 1233.
12. RODMAN W. L. Cancer and precancerous conditions. *Ann. Surg.*, 1914, 59 47.
13. SCHERENBERGSKY J. W. Cancer mortality in the ten original registration states. *J. Am. M. Ass.*, 1925, 85 1175.
14. SIMMONS C. C., and DALAND, E. M. Carcinoma delay in its surgical treatment. *Boston M. & S. J.*, 1920, 183 208.

15. *Idem*. Carcinoma delay in its surgical treatment. Boston M & S J 1924, 190: 1
16. STOUT, A. P. Human Cancer. Philadelphia: Lea and Febiger 1932
17. VAUGHAN, H. F. The function of health departments in the control of cancer. Address presented at the 15th Annual Meeting of the American Society for the Control of Cancer. New York, March 3, 1928
18. WAINWRIGHT, J. M. The campaign against cancer. Penn M J, 1909, 12: 924.
19. *Idem*. The reduction of cancer mortality. New York M J 1911, 94: 1165
20. *Idem*. Report of the commission on cancer. Penn M J, 1915, 19: 96
21. *Idem*. The cancer decalogue. Observations on melanocarcinoma. Internat. J. Surg. 1917, 30: 6.
22. *Idem*. What the medical profession should do about cancer. Address presented at the 15th Annual Meeting of the American Society for the Control of Cancer. New York, March 3, 1928
23. WERRELL, W. Arch. f. Gynaek. 1920, 135: 1.
24. WELLS, H. O. Cancer statistics as they appear to the pathologist. J. Am. M. Ass. 1927, 86: 399
25. *Ibid.* p. 476

CLINICAL SURGERY

FROM THE ST HILDEGARD HOSPITAL

NEW METHODS IN GALL-STONE SURGERY

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THE general rules for operating upon an obstructed papilla do not differ very much in the different clinics of the world. If it is impossible to remove stones through a supraduodenal incision in the common duct, we usually try to extract them through a second incision in the retroduodenal part of the common duct, after extensive mobilization of the duodenum. We do not always succeed with this method either, in which case we resort to the radical method of laying bare the papilla across the duodenum.

Of course, we realize that by the two just mentioned methods, the retroduodenal and the transduodenal, the operative risk increases. The danger in the retroduodenal method lies in the fact that the tissue behind the duodenum has very little resistance to infections of any type. We note very often at postmortem examination a steady increase in infection in the retroduodenal region, in spite of the fact that it may have completely ceased in the intraperitoneal area. The retroduodenal region is also a favorable site for postoperative bleeding in the presence of cholemia.

For all these reasons many surgeons have abandoned the retroduodenal operation completely in favor of the transduodenal route. The transduodenal route also has its drawbacks as we very well know, for it carries a high mortality rate, even if done by an able surgeon of long experience.

The operative risk increases as the infection and cholemia progress. To judge from all large series of cases we are faced with untoward results in 50 per cent of the cases, and the risk is even greater in patients of advanced age. The surgeon is confronted with the knowledge that in spite of a perfectly executed operation he can do little to avoid many imminent complications.

In the following case I tried a new method which proved to be extremely successful, especially in view of the desperate condition of the patient who was in a state of cholemia, and infection was far advanced.

A man of 63 years, had suffered for years with gall stones. He recently had an attack of colic followed by jaundice which lasted for several weeks, and lately he has been having chills. He was brought to the clinic and we found the patient in a very bad general state. Besides sepsis and cholemia he showed signs of an acute peritoneal irritation in the upper abdomen. Our suspicion that this was due to an acute pancreatitis was confirmed by the finding of large quantities of diastase in the blood. To have operated immediately would have given but little chance of success. Ice compresses were applied in the hope of localizing and diminishing the symptoms of general peritonitis. Fortunately the symptoms did decrease during the following days, but a sudden flare up of all symptoms forced us to operate immediately.

I opened the abdomen through a costal incision (Figs 1, 2, 3). A few words about this incision. It lies a little over the costal arch so that the base is formed by the costal bones. We can thus avoid all postoperative hernias with certainty, even in the presence of extensive suppuration. This could be proved during the 10 years this incision has been practiced in my clinic.

After the peritoneum was opened numerous necroses in the fatty tissue were visible. The gall bladder was opened and numerous stones were removed. The badly inflamed mucous membrane of the bladder was quickly electrocoagulated (mucoclasia); the common duct was opened in the supraduodenal area, and many stones were extracted but it was impossible to empty the papilla completely of stones through this incision. To carry on further manipulation by the retroduodenal or transduodenal routes would be taking too great a risk because of the general state of the patient, especially in the presence of acute pancreatitis.

I decided not to operate further at this time so simply introduced a small drain into the common duct, the drain reaching the stones. The common duct was then tightly sewed around the drain. Our idea was that should the patient survive we would try to dissolve the stones by the injection of suitable dissolving liquids by way of the drain. The operation was thus performed very quickly and the recovery of the patient was so satisfactory that, on the fifth day we could begin with our experiment.

Daily injections of several cubic centimeters of ether were made upon the stones. Ether is one of the best soluble liquids for cholesterin. Our intention was to destroy the compact consistency of the stones by dissolving the cholesterin nucleus, thus reducing the stones to a soft pulp which would easily pass the papilla. That this can be done can be proved very easily by mixing the most ordinary bilirubin calcium stones with ether. The stones crumble

1) Pribram, Der Costalschnitt. Deutsche Zeitsch. f. Chir., 1930, 83, 2. Zur Technik d. Costalschnittes bei Gallenoperationen. Zentralbl. f. Chir., 1934, No. 27.

into a sediment of brown, soft pulp, as can be seen in Figure 4. The cholesterol, after having been dissolved in ether crystallizes into white needles after evaporation (Fig. 5). It still remained to be seen whether or not this experiment could be practiced on a patient with the same success.

On the fifteenth day of the treatment it seemed for the first time that not all of the sodium chlorate solution injected returned but that some of it flowed through the papilla into the duodenum. An immediate X-ray examination after the injection of an opaque liquid confirmed my observation.

In Figures 6 and 7 the biliary ducts are seen filled with the opaque liquid, and over the papilla are two distinct spots showing the position of the remaining stones. It will also be noted that some of the opaque liquid has already passed into the duodenum. Another X-ray picture, taken several days later during treatment with ether shows that the papilla has been completely freed and nearly all the injected opaque liquid has passed into the duodenum.

It was now very easy to manipulate the drain through the free papilla into the duodenum (see Fig. 8). We extracted the drain and 3 days later the fistula on the abdominal wall had completely closed.

I have used the ether method in the 4 other patients who were sent to my clinic to be operated upon for papillary obstruction. All these patients were in very poor general condition with advanced choleraemia and sepsis and had been having frequent chills daily. In all of these patients the operation was completely successful. By means of the X-ray I was able to watch the progress of the freeing of the papilla as shown in Figures 9 to 11, 12, 13.

The injection of ether is borne by the patient generally without complaint. It is important, however, that not more than 2 or 3 cubic centimeters be injected at a time and that the tube should be left open after the injection has been completed or else undue pressure would be produced in the epigastrium, as a result of the evaporation of the ether which takes place at body temperature.

The value of this method seems to be twofold. The operation is very simple and can be done quickly; the operative risk, therefore, is greatly lessened as compared with the risk connected with other operative methods formerly in use. This technique seems to be especially indicated in patients suffering with choleraemia and sepsis, when the most simple operation is also the best one.

We use this method in place of the retroduodenal or the transduodenal method not only in cases in which we are unable to free the papilla by simple incision of the common duct, but also in cases in which there is the least suspicion that all the concretions have not been removed. The ether dissolves stones even when they are embedded in the wall of the common duct, a position difficult to reach by mechanical means. This method has proved of value too in the treatment of biliary fistula caused by stones which were

overlooked in the common duct when operation was first carried out.

The introduction of a drain through the fistula down to the stones and the application of ether, cause in a short time the softening and partial dissolution of the stones and their passage through the papilla. Thus a second complicated operation is avoided.

Other surgeons have also reported good results following treatment of biliary fistulas with this method. By means of the X-ray and the injection of iodized oil through the drain we are able to determine with certainty whether the papilla and the common duct are absolutely freed of stones before we remove the drain. The small remaining fistula will then close in about 24 hours.

This procedure will diminish the number of the so called pseudo recurrences.

A prolonged study of the causes of so called recurrences after gall-stone operations has convinced us that a considerable number of these complications are directly or indirectly due to loss of function of the resected gall bladder. Before explaining the new method of procedure, I would therefore like to summarize our findings concerning the function of the gall bladder as well as regarding the pathological and clinical manifestations following the loss of function.

One of the main functions of the gall bladder is to serve as an overflow reservoir equalizing the oscillating pressure in the common duct and regulating this pressure. The liver does not produce bile continually but in certain rhythmical stages bile is poured forth the quantity produced being influenced by nutrition and other external causes. This interrupted secretion of the liver causes changes of pressure in the common duct but within certain limited bounds much greater are the changes of pressure in the common duct produced by the rhythmical contraction of the papillary muscle, the sphincter of Oddi.

These changes of pressure can be studied very easily in a patient with a drain in the common duct. For this purpose the drain must be placed in such a position that its end will lie above the papilla but far enough from it so as not to interfere with the rhythmical play of the sphincter muscle. The wall of the common duct must be sewed tightly around the drain. The quantity of bile flowing out through the drain must be measured every hour.

We very often notice variations in the outflow of bile, the quantity varying from 0-20 cubic centimeters and even more. A large quantity indicates a closed papilla, while if the papilla is open all of the bile flows into the duodenum so

that the outflow of bile stops almost completely. Figure 14 is a curve showing the amounts of bile collected hourly and illustrates well the papillary function. The rise in the curve corresponds to the time when the sphincter was closed the descent of the curve while the sphincter was open.

These oscillations in pressure are regulated perfectly through the natural function of the gall bladder which fills during the time the sphincter is closed. A constant pressure in the common duct is thus secured. When the gall bladder is destroyed by inflammatory processes, when the cystic duct is closed on account of the presence of stones or when the bladder has been removed by operation, all the unregulated changes of pressure are then transferred to the liver.

Patients usually do not feel the changes in pressure except when the spasm of the papilla lasts a longer time than usual, when prolonged spasms of the sphincter of Oddi are apt to occur. This has been observed in many patients.

That such prolonged spasms really occur I was able to determine clearly by means of the X ray in the case of a woman whose papilla had been absolutely freed. The X ray picture showed all biliary ducts filled with iodized oil with not a single drop passing through the contracted papilla. The spastic contraction of the papilla was maintained during the whole time of the observation i.e., nearly an hour. After this I made an intravenous injection of 1 milligram of atropine sulphate. When it first became evident that the atropine had taken effect (dryness in the mouth and mydriasis) I made a new X ray picture. The papilla was then wide open and the iodized oil was flowing in a wide stream into the duodenum. (Figs. 15, 16, 17)

The patient whose gall bladder does not function properly feels the spasms as very unpleasant sensations in the region of the liver. His complaints are characteristic a feeling of oppression in the upper abdomen, belching, nausea, also a temporary enlargement of the liver is noted. Many patients are constitutionally inclined to spasms of all kinds but in addition we know that some external factors may act as irritants and cause spasms of longer duration cold drinks gastric and enteric processes with or without ulcerations, constipation and intoxication of alimentary origin.

An unregulated increase of the biliary pressure has a much graver effect in the presence of latent hepatitis here reactivation of the hepatitis manifests itself in enlargement of liver due to oedema increase of temperature, and even jaundice.

We find such attacks of hepatitis fairly often in

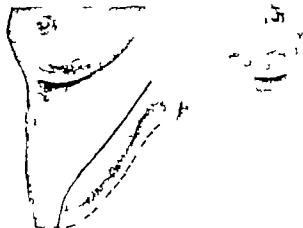


Fig. 1 Costal incision

the recurrent case. Critical observation of these cases shows that the flare up of such types of hepatitis has become more frequent after operation.

We must therefore conclude that in these cases the hepatitis has been aggravated by the cholecystectomy. The explanation of this fact is easily found if our previous statement is recalled the gall bladder the function of which is to regulate the bile pressure and to prevent stasis, is missing. In a certain sense the gall bladder acts as an organ to protect the liver. In addition another fact should be mentioned after the gall bladder is resected we find that the inclination of the sphincter of Oddi to spasms has in many cases increased and especially if the patient is constitutionally inclined to spasms generally.

The nervous regulation of the gall bladder and of the sphincter of Oddi are so connected that tonic contraction of the bladder is associated with the opening of the sphincter whereas a contraction of the sphincter is co-ordinated with distention of the bladder. Such nervous connections are found in most organs limited by a sphincter for instance the oesophagus the urinary bladder, etc. I wish especially to emphasize the relation between the pathological narrowing of the cardia and the dilatation of the oesophagus. That relation is not simply the result of cause and effect but is based on common nervous disturbances. Removal of the gall bladder destroys the complicated nervous mechanism which regulates the bile ducts, and thus is produced a disturbance which in many patients is manifested by an increased inclination to spasm. The increase of pressure as a result of the absence of regulation and the stasis in the bile ducts has a noxious effect upon the latent infection of the liver.

These disturbances of nervous regulation after cholecystectomy are not manifested in all patients



Fig. 2



Fig. 3

by a cramp of the sphincter sometimes—and this is the second form of disturbance after loss of function of the gall bladder I wish to mention—a pronounced insufficiency of the sphincter is noted which causes a permanent flow of bile into the bowel.

These atonic forms of disturbances, as we shall call them, have their own clinical symptomatology—intestinal disturbances, ranking foremost inclination to enteritis and diarrhoea—a diminished stomach secretion up to the point of complete achylia, etc. I have not the space here to enter into a discussion of all of these interesting problems but I would like to mention the fact that we found that the use of pepsin and cholic acid was a means through which the intestinal disturbances which follow cholecystectomy may be overcome.



Fig. 4, left. Dissolution of gall stones in ether

Fig. 5. Dissolved cholesterol crystallizing, the ether having evaporated

The gall bladder has still other functions of which I should like briefly to mention only a few. The concentrated bile of the gall bladder contains in large quantities activators for the digestion of fat. These activators are of the greatest importance therefore the patient who has had his gall bladder removed is handicapped in the digestion of his food, especially of fat.

In addition, the gall bladder is an organ which probably produces in its mucous glands substances of hormonal character which have a great influence upon appetite and palate enabling one to discern and appreciate the different food-stuffs. I will later return to this subject.

Our experiences have therefore led us to be more conservative than formerly in resecting the gall bladder. We now resort to cholecystectomy only in those cases in which the gall bladder has been completely destroyed and its function therefore completely lost. Moreover we are confronted with a new problem not only to conserve the bladder but to restore its lost function if possible.

This problem led us to search for an operative method which would fulfill all the conditions which have been mentioned—the conservation of the gall bladder and at the same time the complete removal of gall stones, the avoidance of all recurrent troubles, the result of the loss of gall-bladder function, which function should be restored by operation. The operative methods designed to conserve the gall bladder which have been in use until now—cholecystotomy and cholecystostomy—do not by any means attain this end.

The follow up of patients who have been treated by cholecystostomy—an operation used rarely and only in special cases—has shown extremely bad results. We are not alone in the observations of these facts. I here mention particularly the



Fig 6



Fig 7



Fig 8.

statistics of Whittaker and Spurling of Boston. Of the 12 cases observed, 5 patients had grave recurrent colics, 4 minor disturbances of different kinds, 1 had no liver symptoms but had a post-operative hernia, 2 patients only were without complaints. It should be mentioned, however, that these 2 cases had been followed for a period of only 25 days after operation. Six patients, that is half of all the cases, had to have a second operation. Four of these showed the formation of new stones, 1 had an acute necrosis of the pancreas, and all of them showed signs of cholecystitis.

Therefore, not only the danger of real recurrence i.e., the formation of new stones in the gall bladder after cholecystostomy, is a big one

but there are still other complaints. All facts led us to believe that cholecystostomy does not secure the result hoped for and therefore should be avoided.

The conditions which must be fulfilled in any operation to conserve the gall bladder are the following. In the first place, one must be sure to avoid every possibility of stasis in the gall bladder—the free outflow of bile from the bladder must be guaranteed. Stasis in the presence of infection is the main factor in the formation of new stones. Cholecystoduodenostomy and cholecystogastrostomy are also designed to avoid stasis in the gall bladder in that they include permanent drainage. Statistics showing the experiences of the later



Fig. 9



Fig 10.



Fig. 11

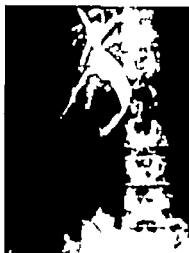


Fig. 17



Fig. 18

results of this operation as published recently by many surgeons are not encouraging, however.

After a certain time it is found that nearly always a grave infection of the gall bladder follows the anastomosis with the bowel, an infection which not only revives the former symptoms of cholecystitis but also gives rise to an ascending cholangitis.

Cases have been observed in which, for instance after the gall bladder has been anastomosed with the stomach, the gall bladder had become a reservoir for remnants of food, thus causing very grave disturbances necessitating radical secondary operation. Such a case has recently been described by Enderlen. For all the reasons given we cannot use this operation in the presence of gall-stone diseases with the purpose of conserving the bladder.

I shall now discuss an operation which seemed to me to be worthy of trial. It insures the free drainage of the gall bladder, not by anastomosing it with the bowel or the stomach, but by effecting a wide anastomosis between the gall bladder and the common duct (Fig. 18). In this way the sterility of the bladder is preserved in spite of the very free outflow of bile, at least the bacteriological medium is not changed for the worse. At the same time the conditions for the healing of the inflammatory processes in the bladder are improved as the possibility of stasis is avoided.

Experiments have shown that the tendency of the gall bladder to heal after inflammation is not so small as we had thought. The gall bladder moreover is conserved with all its functions to regulate pressure and with all its normal secretion. It is really astonishing that, in spite of the clear

logic of this operation, it has not previously been done.

It has always seemed to be the method of choice to operate upon a gall bladder with stasis (*Stauungs-gallenblase*). The first case in which I attempted this new technique, cholecystocholedochostomy, is an illustration. The history is interesting enough to be given in full.

A woman, aged 34 years, had suffered for 3 years with pain under the right costal arch, nausea, and vomiting. She had been operated upon by another surgeon 2 years previously on the suspicion of gall stone disease. There had been no pathological findings except a spastic contraction of the pylorus. For this reason a pyloromyotomy, i. e., cut through the muscle of the pylorus, had been performed.

After the operation not only no improvement but a turn for the worse could be observed, manifested by a feeling of oppression, vomiting, and decrease of weight. The patient was rendered incapable of carrying on her professional duties and was sent to my clinic. The patient, very much reduced in weight, told us that for nearly a year she had not been able to eat anything without a feeling of fullness shortly afterward. She showed an intolerance of all food, not only of fat but also of meat and carbohydrates of all kinds. She could take only small quantities of food and remained in bed nearly all day. We found a distinct tenderness under the right costal arch. The suspicion that the complaints were due to ptosis of the stomach was not confirmed by the X-ray examination. Cholecystography revealed a badly filled bladder but of clear outline, emptied slowly.

Operation was done under spinal anesthesia. The gall bladder was enlarged, was under much tension, and could not be emptied by pressure. The wall was thin and showed no signs of any grave inflammation. Adhesions between the neck of the bladder and the hepatoduodenal ligament caused a kink in the extremely long cystic duct. The bile secured by puncture showed the typical dark green color characteristic of that when stasis is present. I now effected, in the manner mentioned, a wide anastomosis between the neck of the bladder and the common duct.

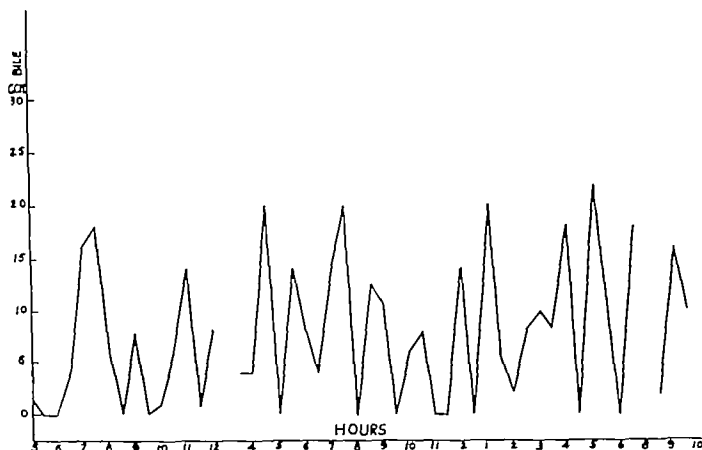


Fig 14. Curve showing contraction of the papilla.

The effect of the operation was remarkable. The symptoms vanished almost immediately and the patient became astonishingly hungry within a few days after the operation—a surprising contrast to the constant lack of appetite before the operation. The further recovery of the patient was very rapid and she was able to eat any kind of food. Increase of weight was 15 pounds within a short time. During the whole time of further observation she never had any complaints.

To illustrate the improvement of the reabsorption of food further I should like to describe some experiments I made with this patient. It is known that for the digestion and the best reabsorption of fat not only the lipase of the bowel is needed but also the bile which increases the work done by the lipase in the sense of an activator.

According to our study the bile of the liver does not act nearly as effectively as does the bile of the bladder. The activating effect of the bladder bile sometimes surpasses the measure which could be expected from a more highly concentrated bile. From this fact it must be logically concluded that the bladder produces still other activating substances which perhaps are secreted by the glands of the gall bladder wall. And now to return to the experiments which were made in the case referred to.

Findings before the operation. In the duodenal juice large quantities of lipase were noted, but the activating effect of the duodenal bile was only slight. Digestion of fat was very poor. This was proved by the lack of a normal increase in the curve showing the bloodfat in the culminating point of digestion. Figure 19 shows a normal curve for blood fat during digestion with an increase in the culminating point nearly in the sixth hour after a meal. For comparison Figure 20 shows a flat curve which indicates poor reabsorption of fat. The activating value of the bile of the bladder secured by puncture during operation was extremely high.

To sum up in spite of the fact that the duodenal juice contained a normal quantity of lipase and in spite of the fact that the activating value of the bile of the bladder was high, the activating value in the duodenal juice was very low. The digestion of fat was very poor as could only be expected when we realize that the bile of the bladder could not flow freely into the duodenum and thus its activating effect was lost.

After operation i.e., after relief of stasis in the bladder and after the establishment of free drainage of the bile of the bladder into the duodenum the duodenal juice obtained through a duodenal tube showed in contrast to our former finding a high activating value. Tolerance and digestion of fat became quite normal. This could be demonstrated by the presence of a normal curve as to blood fat. The favorable effect of all this on the patient has already been mentioned: an increase in appetite and a gain in weight within a short time.

Encouraged by the excellent result in this first trial I used the operation in several other cases with the following modifications in technique.



Fig. 5



Fig. 16



Fig. 17

Fig. 15 Sphincter muscle in contraction.

Fig. 16 Ten minutes later after having injected 1 cubic centimeter atropine. Sphincter begins to open itself.

Fig. 17 Few minutes later. The sphincter is now widely opened. There is present a free outflow into the duodenum.

The region is laid bare through the costal incision described. The gall bladder is punctured and its liquid contents are removed, and the bladder washed out with a solution of sodium chloride. After the anterior wall of the common duct is prepared and after the small blood vessels which are nearly always found in this part are ligated, the common duct is opened through an incision 2 to 3 centimeters long. Calculi if found are removed and it should be determined definitely that the papilla is perfectly free. Then the bladder is opened in the upper interior wall by an incision just wide enough to remove all stones present. A new incision is then made in the neck of the bladder, the incision being made the same length as that in the common duct. Two catgut sutures fix the ends of both incisions and draw together the walls of the common duct and the bladder. While the assistant distracts the two holding sutures, suture of the posterior part of the anastomosis can be done very easily. In the same way suture of the anterior part of the anastomosis is perfected. The suture line is protected by serous tissue from the neighborhood, especially from the hepatoduodenal ligaments.

When signs of more grave inflammation in the bladder are noted or when many small stones are found, it is advisable, before the anterior suture is completed, to introduce through the bladder and the anastomosis into the common duct, a small drain with several lateral holes, the drain to head toward the papilla. This drain has a double purpose: (1) on the days following the operation the common duct and bladder can be washed with a

solution of sodium chloride or a solution of nitrate of silver which has proved its value in treating inflammation of the bladder. (2) In the presence of stones which could not be entirely removed it is possible to carry out the ether treatment described. Around this small drain conducted outward the incision in the bladder is tightened with sutures. Another larger drain, which can be removed on the third day, is securely placed near the region of the anastomosis. Sometimes bile is found to flow out for 2 or 3 days after operation.

At first I used this technique only in cases in which, aside from the finding of stones, no remarkable pathological changes had taken place in the wall of the bladder.

In view of the excellent results obtained in these cases I decided to use the method also in cases in which the gall-bladder walls were badly inflamed and in those in which the bladders were hydropic. Only those in which the wall of the bladders were totally destroyed and those in which abscesses were present were eliminated. In these latter cases mucoclasia¹ should be performed.

In this way I was able to conserve the bladder in the majority of patients brought to my clinic. Of 11 patients thus operated upon I did not have a single mortality. The recovery in all of the patients was excellent, in fact less complications were encountered than after the best cholecystectomy.

First of all, on the third or fourth day after the operation a surprising but common sequel is noted

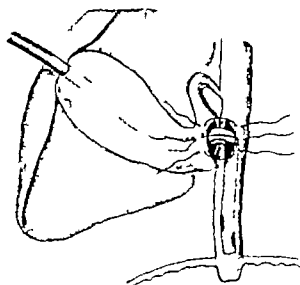


Fig. 18.

patients develop an appetite which sometimes increases to the point of a pronounced feeling of hunger. It is a well known fact that this does not occur even when patients make the best recovery after cholecystectomy. Food tolerance after cholecystectomy is diminished for weeks and months and for good reasons the rule that a strict diet be prescribed is observed. I have often made the interesting observation that cholecystectomized patients complain that all food has the same taste and that the gift for discerning the taste of different foods becomes less pronounced after the loss of the gall bladder.

Quite different is the story of the patient who has been treated with cholecystocholedochostomy. The patient shows not only as mentioned, an appetite extraordinary for the third or fourth day after operation but in the first week he tolerates

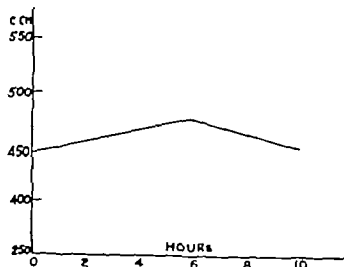


Fig. 20. Curve showing bad reabsorption of fat.

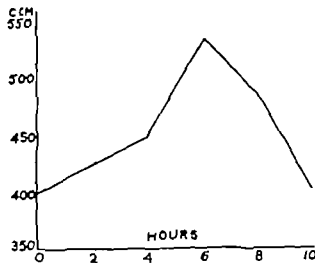


Fig. 19. Normal curve, good reabsorption.

food much better than could be expected from his condition before operation.

I have observed patients whose tolerance for food had become so poor during the course of the gall-stone disease that they could not only not tolerate fat but even meat and eggs could not be eaten. On the fourth day after operation, however, these same patients were able to eat food of every kind, a thing they had not been able to do since the beginning of their illness.

I wish particularly to emphasize the food question, the increase in tolerance for food being one of the most interesting and most common sequel after cholecystocholedochostomy. This fact does not seem so extraordinary when we recall our experiments concerning the function of the gall bladder and the activating importance of the bile of the gall bladder.

The number of patients operated upon by this method and the period of observation is too short

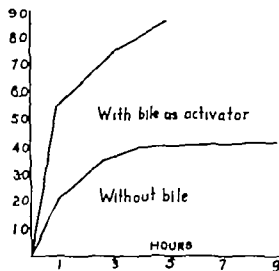


Fig. 21. Effect of activators. Mixture of pancreatic lipase of distinct titre with oil emulsion.

(the first case being under observation for a year) to enable us to form a definite opinion of the value of this new operation. To be able to say something really definite we should have not only thousands of cases but our study should be carried over several years. We must remember that 50 years have elapsed since cholecystectomy came into use and it is only recently (see especially the report of the Congress in 1932 at Vichy concerning the end-results of cholecystectomy) that doubts have been expressed as to the advisability of removing a functioning gall bladder.

At any rate, based on the excellent results I have obtained, I believe that this operation merits further investigation. One fact I believe should be stated: cholecystocholedochostomy seems to be the most logical operation to use in cases in which the gall bladder is in a state of stasis.

One other thing should be mentioned: surgeons and physicians all agree that the chances for favorable results of the operation are best when the patient is operated upon in the early stages of the disease rather than when the disease has progressed. However the arguments of physicians and surgeons against operation performed in the early stages concern principally (aside from the operative risk) the early removal of the gall bladder and the fact that at times there is a remarkably high percentage of recurrent complications.

If by operating at an early stage, we are able to avoid recurrences by conserving the gall bladder with its complete function and, more than this, if we can overcome disturbances in function we should be more emphatic in insisting upon the necessity of an early operation.

THE INCIDENCE OF GASTROJEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY¹

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THE ever perplexing question as to what percentage of patients develop gastrojejunal, or marginal ulcers, following a gastro-enterostomy, creates as much controversy now as when partial gastrectomy was advocated a decade ago to eliminate this serious sequela of a gastro-enterostomy. The incidence of marginal ulcer was found so high in some clinics it was thought that the routine gastro-enterostomy should be discontinued and the more radical procedure partial gastrectomy, done. In 1925 Lewisohn published a paper in which he studied 68 patients and found 34 per cent of gastrojejunal ulcers in their clinic. His paper brought forth considerable discussion and men in numerous clinics felt that a gastro-enterostomy was rarely followed by a marginal ulcer. A recent paper by Gaither in which he studied 100 cases and found the results most satisfactory, would indicate that there is still considerable difference of opinion as to how frequently gastrojejunal ulcer is seen following gastro-enterostomy.

We feel that the results from gastro-enterostomy in the Gastro-Enterological Clinic of the Fourth Medical and Surgical Division of Bellevue Hospital should be recorded. Our clinic is now over 6 years old and we have had the opportunity to study some cases for a long period, therefore we wish to report the cases of gastro-enterostomies entering the clinic from January 1, 1928 to January 1, 1933. During this period we have admitted 583 cases of peptic ulcer, and of this group 440 cases were unoperated upon at the time of admission which leaves only 143 cases that were operated upon before entering the clinic. Of the 143 patients who had been operated upon before entering the clinic, 90 had been operated upon for chronic ulcers, and 79 of these had had gastro-enterostomies performed. We will consider only the 79 cases having had gastro-enterostomies, and of this group we have encountered 13 patients with gastrojejunal ulcers which is 16.4 per cent of marginal ulcers occurring in the gastro-enterostomies during the 5 year period.

Before going into a detailed discussion of the cases we wish to present it would seem worth while to call attention to the fact that our clinic

has been run for the purpose of closely observing patients suffering from peptic ulcer to see what the final results are from the different methods of medical and surgical treatment. During the 5 year period from January, 1928, to January, 1933, 583 patients observed in our clinic made a total of 9,567 visits which would average 16.2 visits per patient for the 5 year period, or 3.2 visits per patient per year. It is important, in drawing conclusions from patients treated for a peptic ulcer, to have frequent observations as to his clinical course, otherwise conclusions are most inaccurate. From the observations in our clinic we feel that a follow up letter is more misleading than helpful in drawing conclusions in ulcer patients. Also any report based on a single observation after one to several years have elapsed, following operations, is also misleading. It is known that the symptomatology of a peptic ulcer runs in cycles, and unless there are frequent periods of observation of the clinical course, this periodicity may be lost and the patient seen in the interval will be symptom free and frequently forgets the discomfort he has suffered a few months before. We would like to call attention to the fact that we have carefully selected the patients that have been referred from our clinic for operation, and of the 583 cases 440 as previously stated, were unoperated upon at the time of being registered in the clinic and of this number we have referred only 33 patients for operation during the first 5 years, which indicates that we have tried to select the patients for operation with the greatest possible care.

To illustrate the seriousness of gastrojejunal ulcer we wish to report a case which came under our observation during 1933 and which is extremely interesting. In this case the gastrojejunal ulcer followed a gastric resection and is not included in our percentage figures, as we are including only those that followed gastro-enterostomy. The case is presented merely to impress the seriousness of a marginal ulcer.

Male, 37 years of age, admitted to the clinic February 16, 1933 having been discharged from the hospital's days before, after being operated upon for a perforated gastrojejunal ulcer. The patient first had pain in his stomach in

¹Read before the American Gastro-Enterological Association on April 30, 1934, Atlantic City, New Jersey.

1928, associated with nausea and vomiting after meals. At the time a diagnosis of duodenal ulcer was made and the patient was placed on a Sippy diet. His condition improved but 6 months later he collapsed on the street and was taken to St. Mark's Hospital with a severe hemorrhage. The patient was transfused and later operated upon in that institution and a resection of the stomach done with a Polya anastomosis for an ulcer of the duodenum. The patient felt well until 5 years later or in 1930, when he had a severe hemorrhage from his stomach and was again referred to the same hospital and at this time he was transfused. Following this he felt well, although he had slight abdominal pain until May 1932 when he had a sudden severe pain which caused him to collapse and he was referred to the Peoples Hospital and operated upon for a perforated ulcer in the jejunum, one inch distal to the anastomosis. The perforation was closed, and the patient made an uneventful recovery and felt well for about 3 months. In January 1933, however, he began having pain in his abdomen which was fairly severe and on January 30, 1933, he was seized with sudden severe pain in his abdomen and was sent to Bellevue Hospital. The operation revealed at the gastrojejunal anastomosis a perforated ulcer of the jejunum one-half inch from the margin of the anastomosis on the jejunal side and the perforation was about one-quarter of an inch in diameter and surrounded by plastic exudate. The perforation was sutured but due to marked linkage it was necessary for the operating surgeon to do an entero-enterostomy between the proximal and distal loop of the jejunum.

The patient was seen in the clinic 5 times during the early part of 1933 and was last seen on May 3, 1933 when he felt quite well and had been symptom free for 3 weeks. X-ray series were purposely not ordered immediately following his operation due to fear of additional trauma from manipulation at the site of the anastomosis. This patient, of course, illustrates a very dramatic picture of what can happen from a peptic ulcer in spite of the fact he was receiving medical treatment for his ulcer when the first hemorrhage occurred. For anyone to offer a prognosis on this case would be mere speculation and the case is presented to illustrate the seriousness of gastrojejunal ulcer.

CASE. Male Russian Jew 58 years of age admitted to the clinic, July 4, 1925. Before admission to the clinic he was complaining of abdominal pain after meals which would come on 2 to 3 hours after eating and it would bother him at intervals of few weeks to few months at a time, although he had been operated upon 3 times for ulcers of his stomach. Patient was first operated upon in 1922 at Beth Israel Hospital, New York City for a duodenal ulcer. Previous to his operation he had had ulcer symptoms for one year and had had medical treatment for his ulcer without relief of his symptoms and operation was advised. A gastro-enterostomy was performed and the patient was well for 6 months after which he began having severe pain which was similar to that preceding his operation but more severe. He was under medical treatment and very little relief was obtained from his symptoms. X-ray series on December 17, 1925, revealed a duodenal ulcer but otherwise negative. Patient first entered Bellevue Hospital December 16, 1925, and was discharged January 3, 1926. He was operated upon December 30, 1925. At operation the omentum and stomach were found adherent to the anterior abdominal wall with the transverse colon fixed to the site of gastro-enterostomy. The duodenum revealed healed ulcer one inch distal to the pylorus. The gastro-enterostomy was placed high on the posterior wall of the stomach with a jejunal ulcer one half inch from the stoma on the efferent loop of the jejunum, penetrating into the transverse colon. The ulcer was excised from the jejunum but its base was

left attached to the transverse colon, and carbolized and inverted. The gastro-enterostomy anastomosis was dissipated and the stomach wall closed with 2 layers of No. 1 chromic catgut. An end-to-end anastomosis was done in the jejunum No. 1 chromic being used for the closure. Convalescence was uneventful, patient was seen regularly in the follow-up clinic and on March 7, 1926, he had gained 18 pounds in weight but was having an occasional burning sensation after eating but was following his diet regularly. The patient was seen at monthly intervals during April, May, June, July, August, and September and during all of these visits complained of slight abdominal discomfort but no typical ulcer pain. On his last visit October 3, 1926, he had gained 23 pounds. He failed to return to the follow-up clinic and on September 4, 1927, could not be found at his previous address. He was re-admitted December 17, 1927, complaining of a burning pain in the epigastrium, belching of gas of a few days' duration. X-ray series December 18, 1927, revealed a duodenal ulcer. Patient was again operated upon December 23, 1927. There was found an ulcer in the first portion of the duodenum on the anterior superior surface and marked adhesions in the right upper quadrant but the site of the former gastro-enterostomy was inspected and there was no evidence of obstruction to the jejunal anastomosis. The duodenum was separated from the under surface of the liver and the ulcer was infolded with No. 3 chromic pursestring sutures but not excised. The patient made a rather stormy convalescence, developed pneumonia in the right lower lobe, following which he developed emphysema. He was operated upon February 18, 1928, for an emphysema of the right chest and the eighth rib as the posterior axillary line was resected. He made an uneventful convalescence and was discharged from the hospital March 9, 1928. After coming under our observation July 4, 1928, patient continued to have abdominal discomfort but returned to the clinic at irregular intervals, although he was instructed to return at weekly intervals he came back at periods of 3, 4, to 6 weeks. He was put on a Sippy diet when he first entered the clinic and given solin subcutaneously. X-ray series on June 12, 1929, revealed an ulcer of the first portion of the duodenum, no 6 hour gastric retention. In spite of these findings he returned for treatment rather sporadically and on September 20, 1929, he entered Post-Graduate Hospital and was operated upon for an ulcer of the duodenum. Report from that institution was as follows: "Diagnosis: Pyloric ulcer with obstruction, and marked gastric dilatation. Operation was posterior gastro-enterostomy although there was a definite mass in the region of the duodenum, which was practically impossible to free due to the denseness of adhesions in that region. Patient was discharged from that institution on October 10, 1929." Since then we have seen him in our clinic November 23, 1929, August 7, 1930, August 21, 1930, November 6, 1930, November 20, 1930, July 9, 1931, and July 16, 1931. During all these visits he stated he felt quite well and was following his diet very regularly but has had occasional abdominal discomfort but no real pain simulating an ulcer. X-ray series November 12, 1930, revealed an ulcer of the first portion of the duodenum and a gastro-enterostomy with a normal appearing stoma. X-ray series July 13, 1931, revealed a normal, well functioning gastro-enterostomy with no evidence of a marginal ulcer. He returned to the clinic on November 1, 1931, stating that he had been having severe abdominal pain for 1 month. A gastro-intestinal X-ray series revealed 1 that time gastrojejunal ulcer. He returned for treatment for 1 month and felt improved and discontinued.

It can be seen that this patient was most unco-operative but he had 2 gastro-enterostomies per

formed and each has been followed by a gastrojejunal ulcer

CASE 2 Male, Italian, aged 24 years, admitted to the clinic January 21, 1928. Patient had been operated upon in Bellevue Hospital in December of 1927 for an ulcer. Abstract from the hospital was as follows: Patient had been having epigastric pain since July 1927 which was relieved by food, but would return at 1 to 2 week intervals, and then he would be symptom free for an equal length of time. Occasionally he would be awakened at night by epigastric discomfort which was immediately relieved by the taking of food. X-ray series December 19, 1927 revealed an ulcer of the first portion of the duodenum but no 6 hour residue. Operation December 20, 1927 revealed an ulcer in the first portion of the duodenum just distal to the pylorus, with a definite crater in the ulcer but no other intra-abdominal pathology. A posterior gastro-enterostomy was done. No 1 chronic catgut being used for the anastomosis, and a routine appendectomy. An uneventful convalescence was made and the patient was put on a fourth week Sippy diet on his first visit to the clinic. On March 10, 1928, he complained of some gas in his stomach after eating but felt better than before his operation and on April 25, 1928, he felt well and had no complaints. On June 9, 1928, however he was complaining of pain in the epigastrium, of a burning nature. X-ray series on June 22, 1928, revealed the presence of a deformity in the first portion of the duodenum, and an irregularity of the stoma with a niche on the jejunal side of the stoma. On June 23, 1928 patient states he had a different pain in his abdomen from that before his operation. It usually started to the left of the umbilicus and goes to the right side, and the pain had been present for about 8 weeks and had gradually become worse. He was advised to reenter the hospital for operation and after 3 weeks of dietary regimen, without improvement, he was re-admitted July 20, 1928, for operation with the following findings: Adhesions were found between the duodenum and anterior abdominal wall and on inspecting the previous gastro-enterostomy there was found an area of induration on the efferent loop which was adherent to the colon. This was separated. There was also a perforation extending partly through the walls of the colon but it did not involve the mucosa. The gastro-enterostomy stoma was dissociated, the ulcer of the jejunum excised, and an end-to-end anastomosis done in the jejunum. The duodenal ulcer was still present and apparently showed no signs of healing, so a partial gastrectomy was done, and an anti-colic anastomosis was made following the Polya-Balfour technique. Following the operation the patient developed pneumonia and in spite of this made a very smooth convalescence for the first 4 days and then became quite ill and died on July 26, 1928, from a lobar pneumonia.

In reviewing this case one could criticize the operating surgeon for having operated upon the patient without adequate medical treatment. The patient never had any systematic medical management and was also quite young, only 24 years of age. The marginal ulcer developed within 6 months following his original operation and he was re-operated upon 1 month after the diagnosis was made. One could, in view of our present knowledge, question the advisability of operating upon the patient for a marginal ulcer without having given him more prolonged medical treatment for the relief of his symptoms.

CASE 3. Male Russian Jew 30 years of age, admitted October 20, 1928 with a history of having been discharged from Bellevue Hospital after an operation for an ulcer of his stomach. Résumé of the hospital record is as follows: Admitted September 19, 1928, discharged October 20, 1928. Past history: Patient had had an appendectomy in 1913 for chronic abdominal pain and his present history was that for the past 5 years he has had epigastric distress with heartburn 3 to 4 hours after eating. These symptoms were rather mild until 1 year ago when the epigastric pain became more severe and occasionally awakened him at night. He has been under the care of different physicians without relief of symptoms. X-ray series made on September 26, 1928, were negative for an ulcer of the stomach or duodenum, but in spite of his negative X-ray series this patient was advised to have an operation which was done on October 6, 1928. At operation the gall bladder was found to be normal but there was a definite ulcer on the posterior wall of the first portion of the duodenum just beyond the pylorus, with stippling of the peritoneum, and an indurated area one-half inch in diameter. Operation consisted of a posterior gastro-enterostomy without clamps, the anastomosis between the stomach and jejunum being done with No 1 chronic gut. Routine appendectomy was performed and the abdomen was closed in anatomical layers. On November 24, 1928 about 1 month following his discharge from the hospital, the patient was complaining of pain in his upper abdomen but without definite relation to meals. He was following a fourth week Sippy diet but on December 29 the patient complained that for the past 3 weeks the same pain had been present as before operation. The pain came on before meals and was frequently relieved by food but although an X-ray series on November 21, 1928, revealed the stoma to be normal he continued to complain of pain. X-ray series February 14, 1929 and May 3, 1929 were both negative for a gastrojejunal ulcer but, in spite of the negative X-ray findings, the patient continued to complain of pain similar to that preceding his operation. This patient was given different treatments, including aolin, subcutaneously at weekly intervals over a period of months, without any relief. The treatment was then changed to Saunderson's streptococcus vaccine, subcutaneously with very little improvement and X-rays January 17, 1930, revealed the presence of a jejunal ulcer with the presence of a niche formation, with localized tenderness at the site of the anastomosis. X-ray films taken September 17, 1930, revealed a small niche present just distal to the stoma on the efferent loop, with a localized tenderness at this site characteristic of a jejunal ulcer. His symptoms persisted and he was put on gastric mucin in May of 1931 having been given all other known treatment without any improvement, in spite of the fact that the patient was very conscientious in following his regimen. X-ray series January 17, 1932 revealed just distal to the site of the anastomosis a small niche on the efferent loop of the jejunum with localized tenderness at this area, characteristic of a jejunal ulcer. His symptoms persisted and he was re-admitted to the hospital August 4, 1932 and discharged August 23, 1932 after 9 days of bed rest, with a strict Sippy regimen. In spite of treatment the symptoms have persisted and X-ray series April 26, 1933 revealed the presence of a small niche in the efferent loop of jejunum near the stoma suggesting the presence of a jejunal ulcer with localized tenderness over this area. The patient was last seen March 20, 1934, at which time he still complained of some discomfort but if anything he had felt better during the past 4 months than any similar length of time since his operation.

We wish to call attention to the fact that this patient has been carried along under medical

treatment for the past 5 years and if anything he has been better for the past 12 months than any time since his operation, but what the ultimate outcome of this case will be time only can tell

CASE 4 Male, Russian Jew age 63 years, admitted April 11, 1929. This patient entered the clinic on a follow up letter, he having been previously operated upon in 1923. At the time of admission the patient had no complaints referable to his ulcer and he stated that his only complaint was constipation and occasional gas after meals, and if his bowels moved he felt perfectly well and had no complaints whatsoever. The patient had felt well since his operation some 7 years previous. Previous admission. Admitted to Bellevue Hospital October 31, 1912 discharged November 16, 1912. At the time of his admission to the hospital he complained of epigastric discomfort and constipation for 15 years. The abdominal pain came on 3 to 4 hours after eating and the intake of food and bicarbonate of soda relieved his discomfort. In the early years of his disease he had remissions of pain for months at a time but for the past year a strict diet and bicarbonate of soda has given him very little relief of his symptoms. X-ray series revealed an obstructive duodenal ulcer with dilatation of his stomach. An operation, November 3, 1912, revealed there was an ulcer of the first portion of the duodenum which was large and indurated there was also evidence of a peritonitis about the right upper quadrant. A posterior gastro-enterostomy was done, No. 1 chromic gut being used for the anastomosis. No clamps were used. A routine appendectomy was also done. At the time of admission to the clinic April 11, 1929 the patient's complaint was constipation and he was put on a diet for this. He was referred for X-ray series and barium enema and on May 24, 1929 gastro intestinal series revealed persistent deformity of the inner and outer part of the first portion of the duodenum with normal gastro enterostomy stoma, and without evidence of a niche or localized tenderness. The barium enema on June 18 reported no organic lesions of the colon. In the early part of June the patient began complaining of slight epigastric discomfort, but in view of the negative X-ray reports this was discounted to a great extent and treatment was continued for his constipation. On August 17, 1929, he complained of quite severe pain in the epigastrium and he continued to complain of this for the next 3 months, although he was put on a fourth week Sippy diet and was given salin subcutaneously. X-ray series December 3, 1929, revealed a niche just distal to the stoma in the efferent loop of jejunum with localized tenderness. Diagnosis. Jejunal ulcer. X-ray series on February 1, 1930, revealed the presence of a jejunal ulcer with a small 6 hour residue, at the site of the anastomosis. The patient at this time was complaining of severe pain and he had been under the care of one of the internists of the clinic since his admission in April of 1929. March 1, 1930, the patient was turned over to the surgical group by the internist stating that no further relief could be gotten from medical management and operation was advised. At this time he was again put on ambulatory Sippy diet and returned 1 week later stating that he was greatly improved. At this time he was also put on salin 2 cubic centimeter subcutaneously, and had no complaints until October 9, 1930, when he had a slight epigastric discomfort. This he complained of until November 1, 1930, when his pain again entirely disappeared. X-ray series July 30, 1930, revealed the presence of a deformity of the duodenum characteristic of an ulcer but the jejunal ulcer previously visualized was not seen at this time. Re-examination was advised, and X-rays on August 14, 1930 showed a normal functioning gastro-enterostomy stoma, with no evidence of

a niche in or about the stoma. The patient remained perfectly well until December 17, 1931 when he returned, stating that he had slight pain for a week and X-ray series March 25, 1931, failed to visualize the jejunal ulcer previously reported. X-rays December 14, 1931 revealed an ulcer at the pyloric ring but no 6 hour retention and a normal stoma. At this time the patient was put on Saunderson's streptococcus vaccine, intravenously starting with 50,000 at the first injection and increased 25,000 weekly. On January 14, 1932, the patient was perfectly well, and since January 1932 the patient has been free from symptoms and was last seen December 27, 1932, when he stated that he had felt perfectly well for the past year and a half. X-ray series done May 2, 1932, revealed the presence of a duodenal deformity with a normal stoma and no evidence of niche formation or localized tenderness could be demonstrated.

It is worth while noting that in this patient his operation was done in November of 1922 and he was symptom free until June of 1929, except for constipation. His X-ray series was negative in May of 1929 for a marginal ulcer but a gastro-jejunal ulcer was demonstrated in December of the same year, or 7 years following his gastro-enterostomy. It is interesting to note that this patient had been given up by the internist in the clinic as a medical failure, and after giving him another trial with a Sippy regimen his symptoms disappeared in about 6 months after their onset. With the exception of 2 slight flare-ups, one in October of 1930, or 6 months after he had been entirely free from symptoms, and another in December of 1931 after he had again been free from symptoms for a year's time, this patient has been entirely well. From his repeated X-ray examinations it is certain this patient developed a gastrojejunal ulcer and this type of ulcer can run periodically as does a peptic ulcer.

CASE 5 Male, American, age 33 years, admitted to the clinic March 20, 1920, complaining of pain in the epigastrium. He had been treated in the medical wards of the hospital for a marginal ulcer from March 8, 1920, to March 20, 1920. A résumé of the hospital records revealed that in 1918 he had been operated upon for a duodenal ulcer and a gastro-enterostomy had been performed in the Greenwald Hospital. Previous to the operation he had had epigastric discomfort after meals for a period of 8 years. Following the operation for a period of 4 months he had felt greatly improved but then the pain had returned and for 4 months before admission to Bellevue Hospital he had had tarry stools and had vomited blood for a 3 day period. X-ray series March 21, 1920, revealed the presence of an ulcer in the efferent loop of the jejunum, just distal to the site of the stoma, with the duodenum deformed and a small 6 hour gastric residue present. He was placed on a Sippy regimen and referred direct to the clinic on leaving the hospital. At the time he entered the clinic he was placed on Saunderson's streptococcus vaccine intravenously 25,000 bacteria being administered at the first injection and the amount increased 5,000 a week, so as to avoid any reaction. Immediate relief of pain was attained after entering the clinic and there were no complaints until August 7, 1920 when he complained of some abdominal discomfort which lasted until September

11 when it entirely disappeared. X-ray series August 13, 1930, revealed a small niche distal to the stoma in the jejunum, with localized tenderness at this area, characteristic of a jejunal ulcer. The patient had no further complaints until January 13, 1931, when he had some epigastric discomfort which he complained of until March 5, 1931, when it disappeared after which time he was symptom free for 10 weeks. X-ray series March 21, 1931, revealed a deformed stoma with a niche in the jejunum, distal to the site of the anastomosis which was exquisitely tender to palpation. Diagnosis: Jejunal ulcer. At this time the patient was receiving Saunderson's vaccine, intravenously and was returning weekly for treatment until May 21, 1931, when he had a return of his abdominal pain. Then he was given gastric mucin and on June 11, 1931, he was greatly improved and had very little discomfort. Two weeks later he was symptom free and was on an unrestricted diet. Since that time the patient has been practically symptom free, except for 3 flare-ups of symptoms lasting for 1 to 2 weeks. He was last seen January 24, 1934, at which time he was symptom free and had been so for approximately 1 year. X-ray series March 21, 1932, revealed the following: Folding of greater curvature of the stomach on either side of the stoma, with diminution of the normal jejunal marking in the distal loop of intestine but no niche or localized tenderness present. The evidence indicates a gastroduodenitis but the presence of an ulcer in association with it cannot be substantiated on the basis of the roentgenological evidence at this time.

This patient is of considerable interest as there seems to be very little question about the diagnosis of a gastrojejunal ulcer and with varying types of medical treatment this patient has been symptomatically cured for approximately 1½ years, and this, of course, is important when one is usually taught that marginal ulcers do not respond to conservative treatment.

CASE 6 Male, Irish American, 36 years of age, admitted November 3, 1928, complaining of abdominal pain and having been discharged from the medical service of the hospital the day of admission to the clinic. Résumé of the hospital records was as follows: Admitted October 15, 1928, discharged November 3, 1928. Complaint: Pain in epigastrium coming on 1 to 2 hours after meals for the past 5 years, and it awakens him from his sleep. Occasionally he vomits but usually bicarbonate of soda, or food, relieves the pain. During the past year his pain has been getting more severe and more persistent and he has had very little freedom from his discomfort. X-ray series October 18, 1928, revealed a filling defect in the inner and outer part of the duodenum, characteristic of a duodenal ulcer. A Sippy diet was followed while he was in the hospital. The patient stated that 5 years before he was X-rayed and told he had a duodenal ulcer and was treated at that time for the ulcer with temporary improvement. He made only one visit to the clinic and was admitted to the hospital as an emergency case February 24, 1929, with a history of having been well since his discharge from the hospital until one week before his admission when he began having pain in his epigastrium. About 6 hours before his admission he felt a severe pain in his upper abdomen which caused him to collapse in the street, due to the intensity and was brought to the hospital in a taxi. A diagnosis of perforated duodenal ulcer was made, and the patient operated upon immediately. Operation revealed a duodenal ulcer in the anterior superior portion of the duodenum which had perforated. The indurated area was excised and the duodenum closed

with No. 1 chromic gut, 3 interrupted layers of sutures being used. An uneventful convalescence was made and the patient was discharged from the hospital March 15, 1929, and re-admitted to the clinic March 16, 1929. He was seen regularly in the clinic until August 10, 1929, and at the time of this visit he was complaining of pain in the epigastrium which he had for the past 2 weeks. Although he did not return to the clinic following this visit he was re-admitted to the hospital January 6, 1930, and discharged January 27, 1930. X-ray series January 8, 1930, revealed a persistent filling defect of the inner and outer borders of the duodenum with a 6 hour gastric residue of one-third of the meal. Operation on January 10, 1930, revealed the anterior superior portion of the duodenum an indurated area which had stippling over it and a partial obstruction of the pyloric ring, with slight dilatation of the stomach. A posterior gastro-enterostomy was done with No. 1 chromic sutures for the anastomosis, without clamps. The abdomen was closed in anatomical layers. The patient returned to the clinic February 1, 1930, at which time he was symptom free and his abdominal incision entirely healed, but he made only 2 visits and was last seen March 8, 1930, when he was perfectly well. He was not seen again until August 13, 1931, when he had no pain or complaints but returned March 2, 1933, complaining of severe abdominal pain for the past 3 days. X-ray series March 10, 1933, revealed tenderness over stoma, with a niche formation at the site of stoma. The patient was then put on a first week Sippy diet, with powders, and his symptoms improved. On May 4, 1933, he had gained 12 pounds and was free from complaints. On his last visit November 14, 1933, he was symptom free.

One can see that this patient was a rather uncooperative individual and no matter what the type of treatment was used on this patient a poor result could be expected, as he usually did not return for treatment until he had a return of symptoms, and he also used alcohol and tobacco to excess.

CASE 7 Male, Irish American, age 35 years, admitted to the clinic February 18, 1932, complaining of epigastric discomfort which was severe. He had been operated upon in 1924 for an ulcer of his stomach. Résumé of previous admissions was as follows: Patient admitted to Bellevue Hospital May 27, 1924, discharged June 15, 1924. Complaint: Attacks of pain in epigastrium since 1920 which would come on about 30 minutes to 3 hours after eating and was relieved by food. X-ray series May 29, 1929, revealed a duodenal ulcer but no 6 hour retention. Operation June 3, 1924. An ulcer on the anterior superior portion of the duodenum just distal to the pylorus which was penetrating through the entire coats of the duodenum but the gall bladder was normal. A posterior no-loop gastro-enterostomy was done without clamps, No. 1 chromic gut being used for the anastomosis. The ulcer was inverted by several interrupted mattress sutures and a routine appendectomy was done. At the time of entering the clinic February 18, 1932, the patient had been entirely well until 3 weeks before his admission when he began having epigastric pain which was more severe than that he had previous to his operation. X-rays on February 19, 1932, revealed an ulcer in the first portion of the duodenum but the patient was requested to return for a more careful study of the gastro-enterostomy stoma. Re-examination March 7, 1932, revealed a duodenal ulcer and a gastro-enterostomy functioning normally but no niche suggestive of an ulcer in this region was found. The patient's pain was so severe

that he was advised to enter the hospital for bed rest. He remained in the hospital for bed rest from March 8 to March 13. His symptoms subsided while in bed and on a Sippy diet and he asked to leave the hospital. He returned to the clinic for treatment and his pain became so severe within 2 weeks that he was forced to return to the hospital and was operated upon. In spite of negative X-ray findings a diagnosis of gastrojejunal ulcer was made and he was operated upon March 25, 1932. The abdomen was opened and the duodenum was found mobile but both palpation and inspection were negative for an ulcer. On inspecting the stomach from the previous gastro-enterostomy it was found to be patent and an ulcer was found on the posterior wall of the stomach near the anastomosis. The ulcer was about the size of a five cent piece, and penetrating from the posterior wall of the stomach into the pancreas. As it was not possible to dissociate the anastomosis and excise the ulcer, the only method of approach was a partial gastrectomy. The ulcer in the stomach was freed from the pancreas with difficulty and the jejunum at the site of the anastomosis was excised, and an end-to-end anastomosis done. An antibiotic anastomosis was done between the jejunum and stomach, using the proximal loop to the greater curvature, and distal to the lesser, as it caused less rotation of the intestine by this approach, and No. 1 chromic sutures used. Then an entero-enterostomy was done between the proximal and distal loops of the jejunum.

The penetration of the ulcer into the pancreas necessitated a subtotal gastrectomy as the ulcer could not have been excised by any other surgical procedure. The patient made an uneventful convalescence following the operation and has been seen in the clinic at frequent intervals and was last seen November 15, 1933 at which time he was perfectly well and had no complaints. X-ray examination of the gastro-intestinal tract November 3, 1933 revealed the presence of a gastric resection but no evidence of a marginal ulcer.

It is worth while noting that this patient went for 7 years and 8 months entirely free from symptoms when his symptoms returned which were more severe than those for which he was operated upon. In spite of 2 negative X-ray series his pain was so excruciating that the diagnosis of gastrojejunal ulcer was made and the patient advised to have an operation. This patient illustrates that a marginal ulcer can occur at long intervals following gastro-enterostomy and that in spite of negative X-rays one can have such a complication.

CASE 8. Male, Irish American, 39 years of age, admitted to the clinic December 8, 1930, complaining of pain in the small of his back and epigastrium, with a history of having had stomach pain for the past 10 to 12 years. He had been operated upon in the Jewish Hospital, Brooklyn, only 6 months previous to admission for a perforated ulcer. Five years previous to that he had been operated upon in the Jersey City Hospital, an exploratory laparotomy and appendectomy having been done. X-ray series December 20, 1930, revealed a permanent deformity of the outer border of the first portion of the duodenum, characteristic of an ulcer with gastro-enterostomy, stomach somewhat diminished, with only small amount of barium going through it. Report from the Jersey City Hospital stated

that the patient entered March 22, 1926, discharged April 21, 1926. X-ray series revealed irregular duodenum, other was negative, and he was operated upon April 7, an abdominal exploration revealing that the gall bladder, stomach and duodenum were normal, but an appendectomy was done. Patient was admitted to the Jewish Hospital, Brooklyn, March 14, 1930, discharged March 28, 1930. A few hours previous to admission he was seized with sudden pain in the epigastrium and taken to the hospital as an emergency case and operated upon the same day. At this time an old indurated pyloric ulcer was found which had perforated into the pancreas. Operation consisted of closure of the ulcer and a posterior gastro-enterostomy. The patient had relief from his discomfort for only a few weeks. For the past 4 months he has had persistent abdominal pain which is occasionally relieved by food. Saunderson's vaccine 0.2 cubic centimeters was given subcutaneously and this treatment was continued at weekly intervals. On January 15, 1931, he was on a fourth week Sippy diet and was feeling well and had no complaints. He failed to return regularly to the clinic, but on July 30, 1931, he had no complaints and had been symptom free since January. On August 13, the patient complained of severe pain in the epigastrium, and at this time he was advised to take gastric moccin and a second week Sippy diet. Gastric moccin caused nausea and vomiting and he discontinued it. An X-ray series on September 14, 1931, revealed a deformity of the duodenum characteristic of a duodenal ulcer with the gastro-enterostomy functioning normally. However he continued to have severe abdominal pain and in spite of a strict Sippy regimen and powders he obtained no relief. On October 22, 1931, he was still having severe pain but discontinued treatment and went to a private physician. He returned on September 9, 1932, still complaining of severe pain and was advised to enter the hospital for operation. X-ray series September 4, 1932, revealed a duodenal deformity, stomach normal, and no evidence of a marginal ulcer. Because of the severe pain and prolonged medical treatment however clinical diagnosis of gastrojejunal ulcer was made and operation advised. Operation September 9, 1932. When the abdomen was opened numerous adhesions were found and separated, also a large marginal ulcer on the jejunal side of the anastomosis which had perforated into the pancreas. Exploration of the pylorus failed to reveal any evidence of a duodenal lesion. The stomach was dissociated and the stomach was closed with 3 layers of interrupted No. 1 chromic gut. It was necessary to resect 8 inches of jejunum and to excise the ulcer from the pancreas, and an end-to-end anastomosis to the jejunum was done with No. 1 chromic gut, 3 layers of suture being used. Patient made an uneventful convalescence and has been seen regularly in the clinic and was last seen November 12, 1933, when he had no pain or complaints referable to his abdomen.

This patient illustrates 3 interesting points. First, he had a duodenal ulcer and during an abdominal exploration the operating surgeon failed to find the lesion which is not an infrequent occurrence. Second, the patient had an acute perforated duodenal ulcer and a gastro-enterostomy was done which has been advocated in some clinics in acute perforations. In spite of this he developed a marginal ulcer immediately upon his discharge. Third, the X-ray series in this case were all negative, and the clinical diagnosis of jejunal ulcer was made in spite of the negative X-ray findings.

CASE 9 Male, Irish American, age 33 years, admitted to the clinic March 17 1932 complaining of abdominal pain. He had been operated upon twice for ulcers of his stomach. Patient states that he had had pain in the pit of his stomach since a small child which was relieved by food. It was considered hunger pain until the age of 16 when it became quite severe. He was treated for an ulcer from the age of 16 to 25 but the pain became gradually worse. X rays in 1918 revealed a duodenal ulcer and as the pain became gradually worse he was operated upon in the Brooklyn Hospital in 1925 and a gastro-enterostomy was done, following which he was free from symptoms for a period of 3 years when in 1928 the pain returned. In that year he was treated in the Kings County Hospital, Brooklyn, for 23 days on a milk diet and powders, following which he was symptom free for about 5 months. In April, 1930, his pain was severe and he went to the Mayo Clinic and was re-operated upon. The report from there revealed a perforating gastrojejunal ulcer with the major portion of the lesion being in the stomach, and perforating into the colon, with a duodenal ulcer on the posterior wall perforating into the pancreas. The operative procedure consisted of disconnecting the gastro-enterostomy, resecting the jejunum with an end-to-end anastomosis, and a resection of the stomach, one half of the stomach being removed and a Polya anastomosis being done. Following this operation the patient was free from symptoms until October 1930 when he had a recurrence of pain and since then he has continued to have recurrent attacks of epigastric pain. X-ray series February 18 1932 revealed a partial gastrectomy with a functioning stoma, without localized tenderness, or obstructive signs. The patient made only 3 visits to the clinic when on October 6 1932 he came in complaining of severe abdominal pain with a loss of 4 pounds in weight. X-ray series October 14, 1932 revealed a jejunal ulcer visualized fluoroscopically but the same was not seen on the plates. October 27 1932 patient complained of having had a hemorrhage, with tarry stools, and was in bed for 10 days. On November 3 the hemorrhage had stopped and he was feeling well. Since then the patient has continued to have attacks of pain every 4 to 6 weeks which may last for 1 to 3 weeks and are very severe. The patient follows a rather strict regimen with powders for the relief of pain. X-ray series April 17 1933 revealed the presence of a partial gastrectomy and a niche, with tenderness to palpation just distal to the site of anastomosis. Re-examination was requested in one month. The patient has not returned to the clinic since April 20, 1933.

This case is of interest as the patient had symptoms characteristic of an ulcer from early childhood and he was operated upon at the age of 25 and was symptom free for 3 years. He then developed recurrent symptoms and one year later was re-operated upon for a gastrojejunal ulcer. Following the gastric resection for the gastrojejunal ulcer the patient was well for 1½ years and then developed symptoms of a second jejunal ulcer. We have quite conclusive roentgenological proof that this patient is at the present time suffering from a second gastrojejunal ulcer following a gastric resection for the first marginal ulcer.

CASE 10 Male, Austrian Jew 54 years of age, admitted to the clinic December 11 1930, complaining of severe epigastric pain for 3 months. The patient had been operated upon in April, 1920 for an ulcer of his duodenum in Belle

vue Hospital and the records revealed a gastro-enterostomy was done. Following the operation he had been perfectly well and remained so until 1927 when he had a few symptoms but they cleared up immediately and until 3 months ago he had no real abdominal pain since his operation 10½ years previously. X-ray series November 26 1930 revealed an ulcer of the first portion of the duodenum and a normal gastro-enterostomy stoma. He was placed on a Sippy diet and his symptoms subsided within a few weeks. On January 27 1931 he was entirely symptom free and had been so for a period of 10 days. He was not seen between January and July 16 1931 when he returned complaining of pain in his epigastrium for 3 to 4 weeks. At this time he was placed on Saunderson's vaccine 10,000 intravenously which he received at weekly intervals, increasing the bacteria 10,000 per week. X-ray series August 11, 1931 showed a deformity of the first portion of the duodenum characteristic of a duodenal ulcer but there was no evidence of a marginal ulcer. From July until November the patient returned at weekly intervals and was following a strict Sippy diet in addition to Saunderson's vaccine which was given for 8 weeks without benefit, and then gastric mucin was given for 6 weeks without any relief. In view of his persistent pain he was advised to enter the hospital and was operated upon for a gastrojejunal ulcer in spite of the negative X-ray series. He was admitted to the hospital November 11 1931 and was operated upon November 20, 1931. An ulcer was found on the posterior portion of the duodenum which was not adherent to the pancreas. In section of the posterior wall of the stomach revealed a large marginal ulcer with the transverse colon slightly adherent over the ulcer. The adhesions were freed but the walls had not been completely perforated. The defect was then closed. The anastomosis dissociated and the jejunum was closed in layers with No. 1 chromic gut, but it was not necessary to resect the jejunum. The stomach was also closed with No. 1 chromic gut. A chronic cholecystitis was found but there were no stones. Cholecystectomy was performed. In view of the poor condition of the patient it was thought inadvisable to do any further surgery on the stomach, although there was a definite ulcer in the duodenum. Since the operation the patient has returned regularly to the clinic and has been improved but continues to have epigastric distress. X-ray series October 17 1932 revealed an ulcer of the first portion of the duodenum but no 6 hour gastric retention. X-ray series August 4, 1933 revealed a deformity and tenderness over the duodenum but no obstruction or gastric residue. The patient was last seen October 5 1933 at which time he complained of epigastric distress and pain at intervals but the pains were much less severe than before his operation.

In this case the patient went symptom free for 10½ years after a gastro-enterostomy and then developed severe epigastric pain. In spite of 2 negative X-ray series and systematic medical regimen the symptoms persisted and the patient was operated upon for a marginal ulcer. The history of this case proves that a long follow up is necessary and too much reliance cannot be placed on X-ray findings.

CASE 11 Female, German age 47 years, admitted to the clinic April 24, 1930, having been discharged from the hospital on April 1 1930. At the time of admission to the hospital February 14, 1930, she complained of pain in the right upper quadrant of 3 weeks' duration and for 2 weeks it has been getting more severe. She had been operated

This patient illustrates a gastrojejunal ulcer which occurred 6 years after a gastro-enterostomy which was performed for a true organic stenosis, following a plastic operation for a perforated duodenal ulcer. Both the first and second operations were done by one of us (J. W. H.). The patient was a most co-operative individual and in spite of the absolute indication for a gastro-enterostomy he developed a gastrojejunal ulcer which at the present time is under control with a dietary regimen.

SUMMARY

The cases here presented are reported in detail so as to give a complete clinical picture of each. Of 13 patients 5 were operated upon in hospitals in or around New York and 8 were operated upon at Bellevue Hospital; no 2 patients were operated upon by the same surgeon. From the review of our cases we feel that any conclusions drawn as to the percentage of gastrojejunal ulcers developing after gastro-enterostomy is most inaccurate unless the patient has been followed for a 10 year period, and also seen at frequent intervals with repeated X ray examinations. A follow up letter in stomach cases we believe is not only inaccurate but misleading and instead of being a help usually presents false information. It is seen that 3 of our patients who came to operation developed symptoms of a marginal ulcer after 7 years, one 10½ years following gastro-enterostomy.

When one realizes that the great majority of our patients have been followed less than 5 years and that in 79 gastro-enterostomies we have encountered 13 gastrojejunal ulcers, or 16.4 per cent, and of the 13 cases 3 occurred after 7 years, it would seem that a 10 year follow up is necessary

in drawing conclusions as to the percentage of gastrojejunal ulcers.

It is important to emphasize that, to a great extent, gastrojejunal ulcers run the same course as do peptic ulcers, that is the patients have pain with periodicity and freedom from symptoms for intervals of weeks or months—one reason why the flare ups that are occasionally seen in patients after operation are passed over lightly if X ray examinations have not been taken. Our cases have also illustrated that too much dependence cannot be placed upon a negative gastro-intestinal examination, for patients frequently will have a marginal ulcer in spite of several negative gastro-intestinal series.

Medical treatment should be tried for as long a period as the patient progresses satisfactorily because marginal ulcers will get symptomatic relief from conservative treatment the same as will any peptic ulcer. If the patient continues to have severe pain under medical treatment it usually means the marginal ulcer is perforating into some adjacent viscus the pancreas and transverse colon being the organs most usually involved. For that reason it is best to submit a patient with a gastrojejunal ulcer suffering severe pain to a second operation rather than to continue medical treatment if the pain is not relieved or improved rather promptly under conservative treatment.

REFERENCES

1. GAITHER, C. H. Eventful results of gastric surgery. *J. Am. M. Ass.* 1933, 101, No. 13.
2. LEWISohn, RICHARD. The frequency of gastro-jejunal ulcers. *Surg. Gynec. & Obst.* 1925 40 70-76.

upon 5 years before admission in Germany for a gall-bladder disease and her impression was that the gall bladder had been removed at the time. X-ray series February 24, 1910, revealed the duodenum diminished in size but apparently normal, with a 6 hour residue of two-thirds of the motor meal. Operation February 5, 1910, revealed a normal gall bladder but in the second portion of the duodenum there was an area of induration on the posterior surface which was definitely adherent to the pancreas. A posterior gastro-entostomy was done, No. 2 drainage, gut being tied for the anastomosis. The patient developed a jejunal fistula which discharged for several weeks but the wound healed and the patient was discharged from the hospital April 1, 1910. She was symptom free following the operation and on September 5, 1910, X-ray series revealed the stomach normal but the duodenal bulb could not be visualized. On November 2 the patient complained of pain in the region of her scar and examination revealed a localized abscess in the incision. She was admitted to the hospital for incision and drainage of the abscess. While in the hospital she complained of epigastric pain similar to that which she had previous to operation but more severe. On December 24, 1910, X-ray series revealed gastro-entostomy stoma functioning but a small niche formation at the site of stoma with tenderness over it, characteristic of a post-jejunal ulcer. The patient was discharged from the hospital January 5, 1911, and she returned to the clinic February 1, 1911, complaining of pain in back and upper abdomen. She continued to have abdominal pain although she was on fourth week Sippy diet and Sander's Remedy, intravenously beginning with 10,000 bacteria and increasing by the same quantity each week. October 1, 1911, the patient had a second abscess in the abdominal scar and was re-admitted for incision and drainage of abscess. She remained in the hospital 4 days and since her discharge has not returned to the clinic for further treatment.

This patient developed a gastrojejunal ulcer within 6 months from the date of original operation.

CASE 2. Male, German American, age 40 years, was admitted to the clinic June 1, 1911, complaining of pain in upper abdomen. He has been operated upon for an ulcer of the stomach. Patient stated that following the operation he was well for 3 years and 6 months but since October of 1910 he has had abdominal discomfort similar to that he had previous to his operation but more severe. In January of 1911 he was operated upon in the Wilkeson Hospital, Brooklyn, and at the time he was operated upon it was for a gall-bladder disease, an ulcer being discovered at the time of operation. Operation consisted of a posterior gastro-entostomy for duodenal ulcer, cholecystectomy and appendectomy. Following his operation the patient was entirely well for years and months after which period he began having epigastric distress similar to that previous to his operation. A x-ray series May 20, 1911, revealed gastro-entostomy stoma with a niche at the junction of the afferent loop of the jejunum and the duodenum slightly deformed with a gastric retention of one-fifth of the motor meal at the end of 6 hours. Diagnosis: Gastro-jejunal ulcer.

At the time of entering the clinic the patient was suffering from very severe abdominal pain and he was not on gastric stoma which treatment he followed regularly. September 15, 1911, his weight was 135 pounds or gain of 10 pounds. Since May he has been entirely free of symptoms but X-ray series November 5, 1911, revealed the presence of a post-jejunal duodenal deformity with the structure and function of the stomach normal. The patient has remain-

ed well since last period with very occasional flare-up of symptoms of 1 to 3 days duration about every 3 to 4 months. X-ray series March 24, 1912, revealed the structure and function of the stomach normal in 6 hour retention. X-ray series September 1, 1912, revealed in her cost residue at the end of 6 hours, deformity of bulb characteristic of a duodenal ulcer, and the jejunum at the site of anastomosis markedly stenosed and deformed with a black speck of barium in the region of the stoma, due probably to a niche at the stoma. January 5, 1913, the patient was complaining of severe abdominal pain and again on January 12, but he did not return to the clinic. A biopsy follow-up on April 20, 1913, revealed that the patient had collapsed in the street and had been operated upon in the Wilkeson Hospital, Brooklyn, as an emergency case, presumably for a ruptured ulcer. Requests to that institution for a summary of their findings have not been answered.

This patient illustrates a marginal ulcer but unquestionable resolved symptoms, and X-ray evidence of healing although his symptoms returned and there was positive X-ray evidence that his marginal ulcer had returned. Presumably the ulcer performed necessitating an emergency operation. This case bears out a clinical observation that marginal ulcers will show periodicity the same as do any type of peptic ulcer whether it be gastric or duodenal.

CASE 3. Male, Scotch American, 45 years of age, admitted to the clinic on January 14, 1912, with a history of having been operated upon in June, 1904, for a perforated duodenal ulcer. At that time a Hensley pyloroplasty was done and he was symptom free for about a year when he began having discomfort after eating and was unable to eat large quantities without vomiting. Patient was re-operated upon October 14, 1907, for a peptic ulcerative stoma at the time of operation he had an organic stenosis of the pylorus. A posterior gastro-entostomy was done with No. 2 drainage, sutures for the anastomosis. An intercostal craniotomy was made following the operation. At the time of his 1907 visit to the clinic in January 1908, he was symptom free and has been since his operation in October of 1910. The patient had had symptoms free 10 years previous to the perforation in 1904 and the pain before the perforation came on about 3 hours before meals and lasted for 2 to 3 months at a time, when it would disappear and he would feel perfectly comfortable for a period of 3 to 6 months. The patient remained in the clinic and remained regularly at monthly intervals through 1905 and 1906 and he was symptom free until August 20, 1907, when he complained of abdominal discomfort with occasional vomiting. Gastro-intestinal X-ray series done July 31, 1907, revealed the gastro-entostomy stoma normal in 2 to 6 hour retention. After a restricted diet he became symptom free in 2 weeks and remained well until September 20, 1911, when he complained of severe abdominal pain which he has had for 2 weeks.

The patient's pain was so severe that he was admitted to the hospital September 24, 1911, and remained until October 11, 1911. A gastro-intestinal series was done on October 6 and again on October 20, which revealed a niche in the jejunum just distal to the site of the anastomosis and a diagnosis of acute jejunal ulcer was made. The patient left the hospital symptom free on October 17 and has been seen in the clinic four times since and he has remained symptom free.



Fig. 1 Melano-epithelioma. Diffuse cellular growth and collections of melanin. (Case 1)

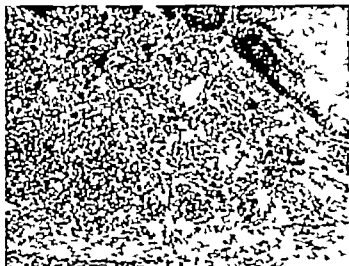


Fig. 2 Melano-epithelioma. Alveolar formation also a few collections of melanin. (Case 2)

She did this, and at that time there was no evidence of recurrence or extension of the process.

CASE 4. A housewife, aged 48 years, registered at the clinic January 1, 1932. Her chief complaints were of discomfort in the upper right abdominal quadrant and of a sinus at the lower end of the spine. The patient gave a very long and detailed history of attacks of abdominal discomfort, nausea, and vomiting aggravated by ingestion of fried or greasy foods, but denied having had jaundice at any time. The sinus mentioned had been present intermittently for 12 years.

The pulse rate, temperature, and blood pressure were normal. Laboratory examinations of the urine revealed a slight trace of albumin. Examination of the blood, including a platelet count, and estimation of the bleeding and coagulation time, did not disclose any variation from normal. Roentgenographic examination revealed that the heart was moderately enlarged, but there were no demonstrable lesions in the stomach or colon.

The heart sounds were distant, and the abdomen was scarred from previous surgical procedures which included

removal of an ovarian cyst from the left side in 1912; removal of a cyst from the right side in 1914; suspension of the uterus in 1914, an operation to relieve adhesions because of abdominal pain in 1915; and excision or section of "a nerve on the right side" for the relief of abdominal pain in 1916.

Sigmoidoscopic examination, limited to 20 centimeters because of the presence of sharp angulation, disclosed the presence of moderately extensive internal and external hemorrhoids and a draining sinus in the posterior median line, 3 centimeters from the anal edge. Operation was advised. The patient returned to her home and remained there until March, at which time she reappeared at the clinic for surgical attention. The fistula was repaired and the hemorrhoids were ligated and excised. The pathologist reported that the specimen removed was inflammatory cavernous hemangio-endotheliomatous tissue, with foreign body giant cells (Fig. 4).

Her convalescence was uneventful and there has been no evidence of recurrence of the condition up to the present time.



Fig. 3. Hemangio-endothelioma, graded 1. The endothelial cells to a large extent have differentiated into capillaries. (Case 3.)



Fig. 4. Hemangio-endothelioma graded 1. A cavernous area made up of erythrocytes and a papillary endothelial growth. (Case 4.)

Melano-epitheliomata are generally considered to be extremely malignant, giving rise to early and widespread metastasis. Case 1 is typical. The original lesion was very small and apparently it was completely removed, but in spite of this the fatal outcome was comparatively rapid. The widespread metastasis was exemplified by the metastatic growths demonstrated in roentgenological examination of the thorax. Radium applied locally and over the groin did not cause appreciable retardation of the progress of the disease. In this case the gross appearance of the original tumor was not unlike that of a comparatively innocent but painful thrombotic external hemorrhoid. The fact that the intensity of the symptoms increased for 3 weeks instead of subsiding as is characteristic of the pain in cases of thrombotic external hemorrhoids, was sufficient to warn the examiner that the condition deserved added consideration and the spotty pigmentation in the skin suggested the possible underlying pathological condition.

Case 2 is more confusing, for the diagnosis was revealed only when the pathologist made his routine examination of the tissue removed at operation. The mass discovered was very small and the anal canal was scarred from previous treatment. The scar tissue so distorted the canal and the flexibility of the tissue in this region that the tumor could not be discovered by gross examination or palpation.

Hemangio-endotheliomata are relatively more rare than melano-epitheliomata are less rapid in rate of growth and metastasis is less frequent. There is less information in the literature concerning these growths, but metastasis has been observed. MacCallum cited a case in which the original growth was in the small intestine and there were hundreds of metastatic growths in the liver. In another case the tumor arose in the region of the scapula of a boy. This tumor was partially resected, but it rapidly recurred and there was metastasis to the lungs. MacCallum stated that the tumor suggested a hypernephroma, but that no tumor was found in the kidneys, suprarenal glands, or elsewhere and that the metastatic growths were about the size of a pea. The same author mentioned Calmers who cited a case in which metastasis was to the internal organs.

Case 3 closely parallels Case 1. The duration of the growth was similar to that in Case 1 as was its anatomical situation. In Case 3 however the growth was painless, although increasing in size. Likewise it resembled a thrombotic external hemorrhoid, but the total absence of pain pointed to some other type of pathological process.

The fact that the patient had previously been informed that she had hemorrhoids, and the fact that she had an abnormally intense fear of cancer account for her close observation and prompt effort to seek a remedy for this condition.

To carry on the comparison of cases Case 4 is very similar to Case 2 in that the neoplasm was discovered at the time of the routine examination of tissue by the pathologist.

These cases evoke consideration of several important phases in the diagnosis of anorectal lesions. It has been stated frequently that actual examination of the anus and rectum is more important than is the history obtained from patients relative to lesions of these parts. However the history cannot be totally ignored as is well illustrated by Cases 1 and 3. It is true that examination is of greater relative value than the history when considering anorectal lesions, but the history frequently will point out the salient differences in lesions that appear to be similar and it cannot be too lightly considered.

Two of the cases described prove the value of the routine microscopic examination of tissue removed at operation. This routine is almost universal when large masses of tissue are removed or when a diagnosis is obscure but it is less rigidly maintained with regard to the comparatively small amounts of tissue removed during an anorectal operation. This is especially true when hemorrhoidectomy is performed.

The prognosis in cases of melano-epithelioma is grave, but it is not beyond reason to expect that if the growth could be discovered soon enough the prognosis could be altered favorably. It is worthy of note that McEuen has used roentgen therapy in six cases of melanosisarcoma and has reported two cures. In general, it is the feeling that these tumors are comparatively resistant to radium and roentgen therapy. Generally the outlook is much more optimistic for patients who are afflicted with hemangio-endotheliomata. These growths occur frequently in parts of the body where they attract attention rather early and surgical excision brings about cure in a large number of cases. The progress of the growth is slower and it is more responsive to the effects of radium and roentgen therapy.

It is interesting, but of little importance, that melano-epitheliomata in this group occurred in men and the hemangio-endotheliomata in women. A case of melanoma in a woman has just been reported by Marino. Kraker reported a case in which melanosisarcoma occurred so low in the rectum that the pathologist discovered epithelial cells of the squamous type on one border of the

tissue removed Goldblatt also reported a case of melanoma in which the tumor projected from the rectum. The patients whose cases are here reported were within the so called cancer age but otherwise their ages were of no significance.

The differential diagnosis of anorectal lesions is not emphasized as frequently as is the differential diagnosis of pathological processes occurring in other parts of the body. These cases serve emphatically to point the need of considering the wide range of pathological possibilities in this region and also the close resemblance between the most benign and most malignant lesions.

BIBLIOGRAPHY

- 1 GOLDBLATT MARION E. Melanoma of the rectum with the report of case J Am M Ass 1925 84 1986-1987
- 2 KRAKER D A. Melanosarcoma of the rectum including the report of a case. Am. J Surg 1924 38 271-272
- 3 MACCALLUM, W G A Textbook of Pathology 5th ed Philadelphia W B Saunders Co 1932
- 4 MARINO A W MARTIN Adorectal melanoma J Am M Ass, 1934, 102 203-204
- 5 McEULY H B Report of six cases of malignant melanoma, treated with X radiation with two cases cured for over five years. Radiol 1930 14 587-590

RENAL TUBERCULOSIS AND NEPHROLITHIASIS AS ASSOCIATED DISEASES

DANIEL N EISENDRATH A B M D F A C S PARIS FRANCE

THE only available statistics as to the frequency of an association of renal tuberculosis and nephrolithiasis in a large number of cases are those of Brongersma Wildbolz, Crenshaw of the Mayo Clinic, and Tardo.

Brongersma had never observed the combination in 1000 cases of renal tuberculosis. Wildbolz has seen the association in only 14 (1.4 per cent) of 1000 cases. In a recent paper 'Calcification in Renal Tuberculosis' Crenshaw of the Mayo Clinic states that there was roentgenographic evidence of definite calcification in 131 or 7.1 per cent of 1817 cases. No distinction is made as to how many of the 131 cases represented simply calcification in the form of lime deposits in a tuberculous kidney and as to how many were cases of true, i.e. well formed, calculus formation found in association with renal tuberculosis. Braasch and Olson of the Mayo Clinic, in a paper published in 1919 stated that, in 19 of 1079 cases of renal tuberculosis, a true calculus formation was found. Tardo quoted by Gottstein collected 10 cases of calculus formation in 1047 cases of renal tuberculosis operated on in Italian clinics.

It is very important, as will be seen later under "General Considerations," to make a distinction between simple calcification and true stone formation in tuberculous kidneys from the standpoint of both diagnosis and of prognosis.

I have been able to find reports of 35 cases published since 1920 to which 5 personally observed cases are added. Although the total number of cases of an associated renal tuberculosis and

nephrolithiasis or ureterolithiasis is comparatively small the possible occurrence of such an association should be constantly borne in mind. In fact, Wildbolz goes so far as to say that one should suspect an associated renal tuberculosis in every case of renal or ureteral calculi associated with infection.

PERSONAL CASES

CASE 1. Clinical diagnosis renal tuberculosis, confirmed by operation. Small calculus in cavity of tuberculous kidney.

Patient was a female aged 29 years, who had had burning on urination and frequency for a year. She had an attack of renal colic 6 months before my first examination, which revealed evidences of right renal tuberculosis. Nephrectomy was performed and the specimen showed two small calculi in one of the cavities (Fig. 1) of a kidney which was the seat of a moderately advanced caseocavernous type of tuberculosis.

The diagnosis of renal tuberculosis was so apparent without roentgenographic evidence, that the latter seemed superfluous. Possibly the passage of a similar calculus had been the cause of the severe renal colic 6 months before. The calculi found at the time of operation were still attached to the wall of the cavity and had evidently been formed around a nucleus of necrotic material.

CASE 2. Clinical diagnosis calculous pyonephrosis. History of passage of calculi. Multiple shadows over right kidney region. Nephrectomy. Multiple soft, partly formed phosphatic calculi in cavities of tuberculous pyonephrosis.

A female, aged 38 years, had had frequent attacks of severe pain over the right kidney region associated with chills and fever. These attacks had been noted over a

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BIBLIOGRAPHY

1. GOLDBLATT MYRON E. Melanoma of the rectum with the report of case. J Am. M. Ass. 1925 84 1986-1987
2. KRAKER, D. A. Melanosarcoma of the rectum including the report of a case. Am. J. Surg. 1924, 38 271 272
3. MACCALLUM, W. G. A Textbook of Pathology 5th ed. Philadelphia W. B. Saunders Co. 1932
4. MARINO, A. W. MANTY. Anorectal melanoma. J Am M. Ass. 1934, 102 203 204
5. McEURN, H. B. Report of six cases of malignant melanoma, treated with X radiation with two cases cured for over five years. Radiol. 1930, 14 587 590

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DANIEL N. EISENDRATH, A.B. M.D. F.A.C.S. PARIS, FRANCE

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It is very important, as will be seen later under 'General Considerations' to make a distinction between simple calcification and true stone formation in tuberculous kidneys from the standpoint of both diagnosis and of prognosis.

I have been able to find reports of 35 cases published since 1920 to which 5 personally observed cases are added. Although the total number of cases of an associated renal tuberculosis and

nephrolithiasis or ureterolithiasis is comparatively small, the possible occurrence of such an association should be constantly borne in mind. In fact, Wildbolz goes so far as to say that one should suspect an associated renal tuberculosis in every case of renal or ureteral calculi associated with infection.

PERSONAL CASES

CASE 1. Clinical diagnosis renal tuberculosis, confirmed by operation. Small calculus in cavity of tuberculous kidney.

Patient was a female aged 29 years, who had had burning on urination and frequency for a year. She had an attack of renal colic 6 months before my first examination which revealed evidences of right renal tuberculosis. Nephrectomy was performed and the specimen showed two small calculi in one of the cavities (Fig. 1) of a kidney which was the seat of a moderately advanced caseocavemous type of tuberculosis.

The diagnosis of renal tuberculosis was so apparent without roentgenographic evidence, that the latter seemed superfluous. Possibly the passage of a similar calculus had been the cause of the severe renal colic 6 months before. The calculi found at the time of operation were still attached to the wall of the cavity and had evidently been formed around a nucleus of necrotic material.

CASE 2. Clinical diagnosis calcareous pyonephrosis. History of passage of calculi. Multiple shadows over right kidney region. Nephrectomy. Multiple soft, partly formed phosphatic calculi in cavities of tuberculous pyonephrosis.

A female, aged 38 years, had had frequent attacks of severe pain over the right kidney region, associated with chills and fever. These attacks had been noted over a

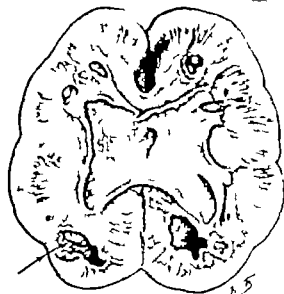


Fig. 3. Tuberculous kidney from Case 3. Note two small calculi lying in a cavity at lower pole. The arrow points toward the calculi. The severe renal colic in this case was probably due to the passage of a similar small calculus.

period of 5 years. The history revealed the passage of calculi. Multiple shadows of varying density (Fig. 3) and a palpable mass were noted over the right kidney region. The diagnosis (from these and other findings) was calculous pyonephrosis. Nephrectomy was done. Examination of the specimen revealed an advanced stage of caseous tuberculous type of tuberculosis with almost every cavity filled by a soft caseous material, which in places had assumed the form of a true calculus (Fig. 3).

The irregular contours and variation of density of the shadows (Fig. 2) so characteristic of calcified tuberculous lymph nodes and of calculi formed in tuberculous kidneys should have led us to suspect the latter condition with secondary calculus formation.

CASE 3. Clinical diagnosis: calculous pyonephrosis. Mass and two shadows over right kidney. Marked pyuria. Previous operation for bladder stone. Nephrectomy. Coral calculus in pelvis and a smaller one in cavity of a tuberculous pyonephrosis.

A boy, 8 years old, had had a vesical calculus removed at age of 5 years. Two shadows (one branching and one smaller) were noted over the right kidney region (Fig. 4) and there was also a mass in the same region. Marked pyuria on right side was also noted. Nephrectomy for supposed non-tuberculous calculous pyonephrosis was carried out. Examination of the specimen revealed a well formed, branching and a smaller, round calculus, lying respectively in the pelvis and one of the cavities of a kidney which was the seat of an advanced tuberculosis (Fig. 5).

The history of an operation for vesical calculus and the presence of shadows which resembled, in

every respect, those found in nephrolithiasis, resulted in the erroneous diagnosis of non tuberculous infection.

CASE 4. Clinical diagnosis: infected stone kidney. Oval shadow and mass over the right kidney region. Operation revealed an oval calculus in the pelvis of the tuberculous kidney.

A female, aged 37 years, had recurrent pain over the right kidney and frequency of urination for past 3 years. Right ureteral rigid and gaping. Unable to catheterize right ureter. Crescentic shadows were present over the right kidney region (Fig. 6). The diagnosis made was renal calculus and non-tuberculous pyelonephritis. Examination of kidney after operation (nephrectomy) revealed a well formed, large calculus filling the pelvis of a kidney which was the seat of an advanced caseous form of tuberculosis (Fig. 7).

The appearance of the ureteral (right) orifice should have led to the suspicion that the concomitant infection was not of an ordinary pyogenic character.

CASE 5. Clinical diagnosis: Renal tuberculosis. Roentgenographic examination not made. At operation large coral calculus in pelvis of a tuberculous kidney.

A male, aged 45 years, gave a history of amputation of the limb for tuberculosis. A marked left pyuria was noted. Examination of indigocarmine, absent. Many ulcers were noted around the left ureteral orifice. Stain was positive for tubercle bacilli in the urine from the left kidney. Hence nephrectomy for renal (left) tuberculosis. Examination of specimen revealed a large coral calculus in the renal pelvis of a kidney which was the seat of an advanced caseous form of tuberculosis. Some time later, operation was performed for tuberculosis of the epididymis.

This case shows the necessity of routine roentgenographic examination (plain film at least) in all cases of renal tuberculosis.

In none of these 5 cases was the correct diagnosis of an association of renal calculus and tuberculosis made. In Cases 3, 4, and 5, we believed the concomitant infection to be of a non-tuberculous character. This, as will be shown under "General Considerations," has been true of the majority of the reported cases. In Case 1, the calculus was probably too small to be recognized by roentgenography. In Case 5 such an examination was not considered necessary.

GENERAL CONSIDERATIONS

Types of calcification and calculus formation in tuberculous of the kidney. In order to make a correct pre-operative diagnosis of the association of calculus formation and renal tuberculosis it is necessary to distinguish calcification in a tuberculous kidney and true calculus formation as shown in Cases 3, 4, and 5 just cited.

1. *Calcification in a tuberculous kidney.* This question has been very thoroughly studied by Braasch and Olson in 1919 and more recently



Fig. 2 Shadows of soft phosphatic calculi as found before operation in Case 2. Note the irregular contour and variation in density of the shadows.

(1930) by Crenshaw who makes the following division:

Group 1 Multiple scattered small areas, generally due to lime deposits. These are seen (a) as single, elongated, irregular faint streaks or (b) multiple punctate areas, scattered over a large portion of the kidney, usually in one of the poles.

Group 2 Single (Fig. 1) or several isolated areas of calcareous deposit which are easily confused with stone. These shadows are of several varieties:

a. Of irregular outline, with fainter shadow than that of stone and varying in size (as in Case 2, Fig. 2)



Fig. 4. Roentgenogram in Case 3. Note shadow of a branching calculus and of a smaller one. (Compare with Fig. 5.)



Fig. 3. Kidney from Case 2. Note the soft phosphatic calculi which fill and assume form of nearly every cavity and dilated calyces.

b. Shadow of very irregular consistence and outline somewhat resembling filigree work.

c. Definite shadows with a density and contour suggestive of stone.

Group 3 Large, regular rounded shadows of variable density in their various portions. As a rule, the kidney is of putty like consistence in such areas. The shadow may vary in density in different portions of the kidney, some portions being so dim (Fig. 8) as to be scarcely discernible while in complete calcination the shadows may assume the outline of a complete cast (Fig. 9) of the kidney and are irregularly divided into lobules.

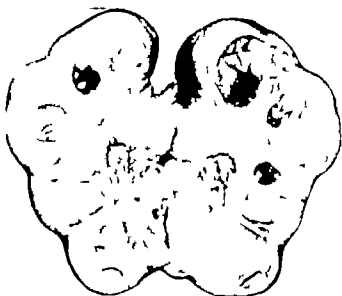


Fig. 5. Kidney from Case 3. Note the typical tuberculous pyonephrosis with a large calculus in the renal pelvis and a smaller one in a cavity.



FIG. 6. Roentgenogram from Case 4 showing irregular or crescentic shadow in right kidney region due to relatively large calculus (see Fig. 7).

2. *True calculus formation in a tuberculous kidney.* There is much difference of opinion in regard to which is primary, the tuberculosis or the calculus. If the latter is composed of oxalates or urates, it seems logical to believe that the calculus formation was independent of the tuberculosis. In the case of calculi composed of calcium carbonate and especially of calcium phosphate the secondary origin seems most probable. The



FIG. 7. Kidney from Case 4. Note the relatively large calculus in the pelvis of a kidney which is the seat of advanced tuberculous changes.

shadows due to true calculi do not differ in intensity or contour from those observed in non-tuberculous cases. This is well shown in Case 3 (Fig. 4). One can readily exclude the majority of extrarenal conditions such as calcified retroperitoneal lymph nodes by the use of the opaque catheter with or without pyelography. The shadows due to such nodes are as a rule characterized by an irregular moth-eaten contour and a variation in the intensity of the shadow. Occasionally these criteria cannot be depended on and uretopyelography (retrograde) must be employed (Fig. 10).



FIG. 8. Moderately advanced degree of diffuse calcification in a tuberculous kidney. (Courtesy of Dr. J. L. Crenshaw and of the Mayo Clinic.)



FIG. 9. Very advanced degree of diffuse calcification in a tuberculous kidney. (Courtesy of Dr. J. L. Crenshaw and of the Mayo Clinic.)



Fig. 10. Roentgenogram from case in which the shadows of calcified retroperitoneal lymph nodes resembled those due to renal calculi. Note their change in position and their extra ureteral location as shown in ureteropyelogram.

Sermet has recently reported a case in which three calcified tuberculous nodes yielded shadows which were interpreted as calculi lying in the pelvis of a tuberculous kidney. At operation three calcified lymph nodes were found lying in close proximity to the renal pedicle.

One must also bear in mind that a true renal or ureteral (Fig. 11) calculus may be associated with a shadow due to a tuberculous lymph node.

Clinical groups. All of the cases thus far reported may be grouped as follows:

Group 1. Calculus and tuberculosis on the same side (Table I). Of the 40 cases (including my own 5 cases) reported since 1920, the majority—26 cases, belong in this group. They may be summarized as follows:

Pre-operative diagnosis (26 cases)

Renal or ureteral calculus with infection	13
Same and renal tuberculosis	1
Non-tuberculous pyonephrosis	2
Renal tuberculosis only	9
Suspected renal tuberculosis	1
Suspected renal tuberculosis and calculus	1

Thus we see that in only one case (Case 6 of Group 1) was the correct diagnosis made before operation.

Roentgenographic evidence of calculi. Of the 19 cases, in which the results of the roentgenographic examination are given, only 3 yielded negative

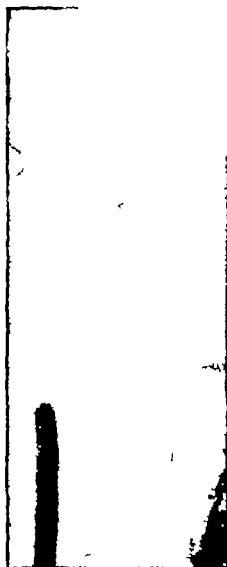


Fig. 11. Simultaneous presence of ureteral calculus in the pelvic portion of the ureter and of a calcified lymph node. (Courtesy of Dr. Joseph S. Eisenstadt.)

results. In 1 of my own cases (Fig. 2) the shadows were due to deposits of lime salts rather than to true calculi.

The same was true of one of Howald's cases.

Group 2. Tuberculosis on one calculus on the opposite side. The 5 cases in this group are of especial importance. At intervals varying from 26 days to 1 year after a nephrectomy for renal tuberculosis, an anuria due to an obstructing calculus in the ureter of the remaining kidney developed in the 5 cases of this group. In one of the cases (Grondahl) the roentgenographic examination was negative at the time the nephrectomy was performed. In the 4 others, there is no mention of such an examination.

Why calculus formation occurs in the remaining kidney following nephrectomy for tuberculosis is still being debated. Howald is of the

TABLE I—SUMMARY OF CASES GROUP I CALCULUS AND TUBERCULOSIS ON SAME SIDE

Author	Clinical diagnosis	X-ray	Treatment	Specimens	Course
Barney and Minter J Urol 4, 304, 1900	Infected stone kidney Retracted right ureteral orifice	Positive (large renal shadow)	Nephrectomy	Tuberculosis and cal- culus (renal)	
Bruchin Zucker f Urol 431, 1913	Tuberculous pyelonephrosis	Not given	Nephrectomy	None	
Phillip J Urol 19 54, 1913	Ureteral calculus. Bladder and gonads negative for tuberculosis	Shadow of calculus in upper third of ureter	Nephrectomy	Tuberculosis and calculus (ureteral)	
J. J. Williams Semin med 37 65, 1914	Nephrocalcinosis	Large and small shadows in right kidney region	Nephrectomy	Tuberculosis and mul- tiple calculi (renal)	
L. K. McIntyre Arch f Clin Chr 141, 4, 3, 1916	Suspected renal tuber- culosis. Stone negative for tuberculosis	Not mentioned	Nephrectomy	Tuberculosis and small calculus in pelvis	
Adler Racz Zucker f Urol Chr 1, 304, 1908	Renal tuberculosis and ureteral calculus (stone not)	Positive for ureteral calculus	Nephrectomy	Advanced renal tuber- culosis	
R. F. O'Neal Ann Am G U Surg 1, 37, 1908	Suspected renal tubercu- losis associated with renal calculus	Positive for renal calculus	Nephrectomy	Tuberculosis and renal calculus	
B. A. Thomas J Urol 15, 411, 1919	Renal tuberculosis pyelonephrosis	Negative	Nephrectomy	Tuberculosis and large renal calculus	
Bowditch Zucker f Urol Chr 37, 18, 1909	Renal calculus	Positive (large shadow)	Pyelotomy		Report of gonads nega- tive from same tissue be- fore operation was reported positive after pyelotomy for renal calculus had been per- formed
Idem	Infected stone kidney	Positive (3 fairly large shadows)	Nephrectomy for calculus	Examination of a specimen excised from kidney at operation revealed tuber- culosis	
Idem	Renal calculus	Positive (small shadow)	Pyelotomy for calculus		Same as in Case 8, but in this case there was sterile (postoperative)
Idem	Non tuberculous pyelonephrosis	Negative	Nephrectomy	Found tuberculous pyelonephrosis and two calculi	
Idem	Renal tuberculosis	Negative	Nephrectomy	Found calculus in pelvis	
Idem	Same	Same	Nephrectomy	Thick, friable secretions in renal pelvis	
S. Barnett J Urol 20, 441 1910	Renal tuberculosis	Positive (large shadow)	Nephrectomy	Tuberculosis and large renal calculus	
Idem	Same	Same	Nephrectomy	Tuberculosis and two kidney and calculus	
Cham J Urol 1, 81, 1910	Calculus pyelonephrosis	Positive (large and several smaller shadows)	Nephrectomy	Tuberculosis and multiple large calculus	
Idem	Renal tuberculosis	Negative	Nephrectomy	Tuberculosis and large calculus blocking outlet of renal pelvis	
Taylor Urol & Gynaec Rev Jan 1914	Calculus pyelonephrosis	Positive. Two dis- tinct shadows	Nephrectomy	Tuberculosis and calculus embedded in wall of the ureter	
Idem	Renal calculus and hydronephrosis	Positive. Transverse shadow	Nephrectomy	Tuberculosis and multiple calculi (some large and several smaller in pelvis)	

TABLE I.—SUMMARY OF CASES GROUP 1 CALCULUS AND TUBERCULOSIS ON SAME SIDE—Continued

Author	Clinical diagnosis	X-ray	Treatment	Specimen	Course
21 Taylor Urol. & Cutan. Rev. Jan. 1934	Calculus pyelonephrosis	Not mentioned	Nephrectomy	Tuberculous and renal calculus	
2 Eisenrath (Case 7)	Renal tuberculosis	Not taken	Nephrectomy	Tuberculous and small calculus in cavity	
3 Idem (Case 2)	Multiple calculi and pyelonephritis	Positive Multiple shadows	Nephrectomy	Multiple soft calculi in cavities of ad- vanced renal tuber- culosis	
22 Idem (Case 3)	Calculus pyelonephrosis	Positive Coral and smaller shadow	Nephrectomy	Advanced stage of renal tuberculosis with coral calculus in renal pelvis and smaller one in a cavity	
23 Idem (Case 4)	Renal calculus and advanced non-tuber- culous pyelonephritis	Positive Crescentic shadow	Nephrectomy	Oval phosphatic cal- culi lying in pelvis of tuberculous kidney	
24 Idem (Case 5)	Renal tuberculosis	Not taken	Nephrectomy	Large coral calculus in pelvis of a tuberculous kidney	

TABLE II.—GROUP 2 TUBERCULOSIS ON ONE SIDE AND CALCULUS ON OPPOSITE SIDE

Reference	Clinical diagnosis	X ray	Treatment	Specimen	Course
1. Grondahl Abstr. in Zacher f. urol. Chir. 13 337 1923	Right renal tuberculosis	Negative for ureteral calculus	Nephrectomy for tuberculosis of right kidney	Tuberculous pyelonephrosis	Anuria (4 weeks after right nephrectomy) due to left ureteral calculus which was removed by ureterotomy
2. Jura and Akita Abstr. in Zacher f. urol. Chir. 29, 340, 1930	Renal tuber- culosis	Not given	Nephrectomy for renal tuber- culosis	Tuberculous pyelonephrosis	Anuria 36 days after nephrectomy. Unable to pass ureteral catheter beyond calculus in op- posite ureter. Hence pyelotomy and relief of anuria by retrograde passage of catheter alongside obstructing ureteral calculus
3 Idem	Renal tuber- culosis	Not given	Nephrectomy	Tuberculous pyelonephrosis	Anuria (70 days after nephrectomy) due to cal- culus obstructing opposite ureter. Anuria re- lieved by passage of ureteral catheter. Stones passed 6 days later
4. Howald Zacher f. urol. Chir. 27 118, 1930	Right renal tuberculosis	Not given	Nephrectomy	Tuberculous pyelonephrosis	Anuria (1 year after nephrectomy) due to ureteral calculus on opposite side. Pyelotomy and removal calculus later
5 Idem	Renal tuber- culosis	Not given	Nephrectomy	Tuberculous pyelonephrosis	Anuria (1 month after nephrectomy) due to cal- culus in opposite ureter. Removal calculus by ureterotomy. Relief of anuria

opinion that such calculus formation is favored by the forced feeding in sanatoria.

Group 3. Bilateral renal or ureteral calculi and unilateral tuberculosis (Table III) There were only 4 cases in this group. In Fowler's case, a nephrectomy was performed for the associated lesions. In Iriyawa's case, a large coral calculus was removed from one kidney and a nephrectomy for the associated lesions performed on the other side. In one of Howald's cases nothing had been done, and in the other case, a nephrectomy

**Group 4. Bilateral renal tuberculosis and uni-
lateral stone formation** Only 5 cases belong in this group. Of interest are the cases of D Agata and of Kuzmickij. In the former a large calculus

was removed by nephrotomy from a tuberculous kidney. In Kuzmickij's case a calculous anuria developed 1 year after nephrectomy for renal tuberculosis. Autopsy revealed the presence of two calculi obstructing the ureter of the remaining tuberculous kidney.

Group 5. Bilateral renal tuberculosis and lukuria Gottstein cites 4 cases (those of Helmut, Joseph Kuemmel and Liebermeister). They are of little practical clinical interest except from the standpoint of diagnosis.

TREATMENT OF THE VARIOUS GROUPS

Group 1. Tuberculosis and calculus on same side It is generally accepted that nephrectomy

TABLE III—GROUP 3 BILATERAL CALCULI AND UNILATERAL TUBERCULOSIS

Author	Clinical diagnosis	X-ray	Treatment	Specimen	Course
St. A. Fowler J. Urol. 3: 515, 1921	Bilateral renal calculi	Positive. Shadow (heavy bean size) in pelvis of left kidney and much larger in right renal pelvis	Nephrectomy (left)	Tuberculosis (advanced stage) with calculus size of large bean in pelvis	
Ingram Abstr. in Zacher J. Urol. Chir. 5: 3, 1924	Bilateral renal calculi	Positive. for calculi in both kidneys	Nephrectomy (right) for large renal calculus Nephrectomy (left)	Left tuberculous kidney had small calculus in calyx	Fewer and better treated the calculi
Howard J. Urol. Chir. 27: 3, 1930	Bilateral calculi (renal and ureteral) and unilateral renal tuberculosis (left)	Positive	Nephrectomy done up to time of publication of article		
Idem	Bilateral renal calculi and right renal tuberculosis	Positive. Small shadow in left had very vague and no distinct shadows in right kidney region	Right nephrectomy	Calculus removed from	

TABLE IV—GROUP 4 BILATERAL RENAL TUBERCULOSIS AND UNILATERAL NEPHROLITHIASIS

Reference	Clinical diagnosis	X-ray	Treatment	Specimen	Course
D. Acosta Abstr. in Zacher J. Urol. Chir. 10: 1, 1923	Bilateral renal tuberculosis and unilateral right nephrolithiasis	Positive	Nephrectomy for large calculus in right tuberculous kidney		
Kennedy Abstr. in Zacher J. Urol. Chir. 19: 142, 1926	Bilateral renal tuberculosis and unilateral right nephrolithiasis	No mention	Nephrectomy (left)	Renal tuberculous (left)	One year after left nephrectomy calculus anuria no opposite side. Nephrectomy. Death. Autopsy revealed two phlebotic calculi obstructing right ureter. In right kidney showed 3 tuberculous foci
Howard Loc. cit.	Bilateral renal tuberculosis and unilateral right nephrolithiasis	Positive. Large shadow over right kidney region			
Idem	Bilateral renal tuberculosis and unilateral right nephrolithiasis	No mention	Removal of perinephric abscess (right) from which calculus was evacuated		
Idem J. Urol. 1930	Bilateral renal tuberculosis and nephrolithiasis	Positive multiple shadows	Nephrectomy for calculus in upper pole of tuberculous kidney	Only excised masses contained but showed tuberculous and calculi	One kidney had been removed elsewhere for tuberculosis. Examination showed calculi and tuberculosis

is the best method of treatment, at the present time, for a case of unilateral tuberculosis unless some contra-indication outside of the urinary tract, exists. The same indication exists when either calcification or true calculus formation is an associated condition.

If one has overlooked the existence of a renal tuberculous in a case of unilateral renal or ureteral calculus, the following dangers may be present (a) the persistence of a postoperative fistula (b) the chances of recurrence of calculi are greatly increased.

Every case of renal or ureteral calculus associated with infection, should be examined for the possible co-existence of a renal tuberculosis. In the latter disease plain roentgenography at least, should precede nephrectomy in order to be

able to detect the presence of true calculus formation as an associated lesion. In such individuals the probability of calculus formation in the remaining kidney at some future date, is probably greater than when renal tuberculosis exists alone.

Group 2. Tuberculosis on one side and calculus on the opposite side. If both conditions have been recognized at the first examination of the patient, Howard advises removal of the tuberculous kidney first and of the calculus at a later sitting. The writer believes the danger of a postoperative anuria is greatly lessened in the case of a ureteral calculus on the opposite side, by making every effort first to deliver the calculus by non-operative or operative means before the nephrectomy. The treatment of the calculous anuria which occurs

after operation, is the same as for that which occurs independently of a previous operation.

Group 3 Bilateral calculi and unilateral tuberculosis. In such cases, Howald advises removal of the kidney which is the seat of the tuberculosis and calculus as a first step. In such cases, the writer would prefer to be guided by the same principles as in ordinary cases of bilateral renal (or ureteral) calculi viz. to remove the calculi from the better side first.

SUMMARY

1 The association of renal tuberculosis and of true calculus formation occurs in approximately 1.8 per cent of all cases of renal tuberculosis.

2 One must distinguish between calcification which is found in about 7 per cent of all cases of renal tuberculosis and true calculus formation.

3 Forty cases reported since 1920 the majority of which are instances of true calculus formation in tuberculous kidneys (on the same or opposite side) are tabulated; 5 of the 40 cases are personal observations of the author.

4. The cases can be placed in four clinical groups. The first and second of these are of especial importance. In the former if one overlooks

the concomitant tuberculosis in a case of renal or ureteral calculus, there is the danger of a persistent postoperative fistula as well as of early recurrence of calculi.

The only case in this first group (26 cases) in which a correct pre-operative diagnosis (of associated calculus and tuberculosis) was made is that of Adler Racz (Table I).

In the second group 5 cases reported since 1920 of calculous anuria following nephrectomy for tuberculosis at intervals of 26 days to 1 year, are cited. A number of similar cases were published prior to 1920 by Elliot, Kuemmel and others.

Plain roentgenography even in cases of well marked renal tuberculosis should be considered a routine measure in order to detect the presence of renal or ureteral calculi.

REFERENCES

- 1 BRASCH and OLSON. Surg. Gynec. & Obst. 1919 28 555
- 2 CREMINIAUX J. L. J. Urol. 1930 23 315
- 3 GOTTSTELN G. Handb. f. Urol. 1927 4 312
- 4 HOWALD. Ztschr. f. urol. Chir. 1920 27 118
- 5 SPERMETT J. J. Urol. 1930 30 441

THE TREATMENT OF ACUTE SUPPURATIVE ARTHRITIS

REPORT OF THIRTY SIX CASES TREATED BY OPERATION

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THE following study of the end results in the surgical treatment of acute suppurative arthritis is based upon 36 cases of this disease in which operations were performed at the New York Orthopaedic Hospital during the 15 years from 1918 to January 1, 1933. It will include only the cases in which movable joints were affected, thus excluding those in which the infection involved the sacroiliac joints where restoration of motion is not desired in the treatment. Also, because gonorrheal arthritis is a separate and distinct disease clinically and pathologically rarely proceeding to suppuration seldom if ever requiring incision no cases of this disease are included in the present study. Thus the report will deal only with acute non-specific purulent arthritis in movable joints.

HISTORICAL

The attitude of the medical profession toward this disease has been a singularly variable one. There has always been respect for it but the forms of treatment advocated for its cure have been many and these have often been diametrically opposed to each other in theory. Whether to incise or to aspirate, to mobilize or to immobilize, to disinfect or to irrigate, whether or not a drain should be inserted—these are questions about which there have been many differences of opinion.

In general it may be said that the chief concern of seventeenth and eighteenth century surgeons in such cases was to preserve the life of the patient; that the nineteenth century surgeon tried, in addition, to save the affected limb; and that with the beginning of the twentieth century came the idea of preserving the *function* of suppurative joints.

The attitude of the sixteenth century surgeons toward this disease is well expressed by Peter Lowe, who, in his *Discourse on the Whole Art of Chyrurgerie* (1597) writes of "The tumor or paine in the knees" as follows:

If it tend to suppuration beware to open it, for it is forbidden by our ancients to make deepe incisions under the rotule of the knee because those parts are both sensible

and painefull, and oftentimes evill accidents ensue, so you shall use corroborative remedies, and anodynes, evacuating the matter and cicatrizing the wound, as you have heard in others.

The seventeenth century surgeon Richard Wiseman, was the first to differentiate between acute suppuration in joints and a condition which he called "tumor albus," and which after Koch's time, was recognized as tuberculosis. The failure to distinguish between these two diseases, however, is apparent in the works of writers much later than Wiseman, and possibly accounts for much of the variation in the methods of treatment of purulent arthritis. Even today this differential diagnosis is not a simple one.

During the seventeenth and eighteenth centuries there was a passion for amputation of limbs, often with small provocation and pyarthrosis was not the least of the indications for removal of a limb. Joint suppuration was considered a serious threat to the patient's life and preservation of the limb was not considered feasible. Early in the nineteenth century a revolt against amputations was led by Sir William Ferguson, Astley Cooper, Brodie, and others, and it became the mode to try to save the limb as well as the life of the patient. The conception of the treatment of joint infections at this time is summarized by Sir Benjamin Brodie:

However formidable such cases of rapid suppuration and joint destruction may be they are now much under the control of art, so that the patient will in many instances recover preserving the limb, but not the motion of the joint, which remains immovable. If the joint be purulent, a free opening should be made in a depending situation. It is important that the operation be not long delayed, and that the opening should be sufficiently large to allow the matter to flow out spontaneously, but all this will be of little avail, unless the joint be kept in a state of most complete immobility.

The twentieth century ushers in a variety of new ideas in the treatment of this old disease. It suddenly becomes "criminal," according to one author (Cotton) or "an outrage" according to another (Reich) to treat an infected joint by the "ancient method" of drainage and the introduction of wicks: the one writer is sure that the proper

treatment is to close the joint tightly after incision and washing out of the pus, the other is just as sure that aspiration and lavage is the only treatment. Other authors in this period advocated 'disinfection' of the joint, and many were the kinds of chemicals recommended for this purpose. Chemical disinfection reached its zenith during the early years of the World War in the form of the Carrel Dakin irrigations.

The idea of preserving motion at the infected joint is relatively recent, and it is not yet by any means universally accepted. Even today there are surgeons whose attitude toward such joints is 'Let them ankylose in good position'. To whom the credit should go for first introducing the principle of maintaining function in purulent joints is not known but it was preached at the beginning of this century by Professor Erwin Payr of Leipzig.

In 1881 Macnamara described the use of drainage tubes in the incisions into purulent joints, drains however, were undoubtedly used long before this. Over no other question in the treatment of suppurative arthritis has there been so much controversy. Up to 1914 their use seems to have been general, but since then there has been widespread objection to the insertion of any foreign body into an infected joint. It is argued that drains will cause additional necrosis of tissues, especially of cartilage by pressure, or that they may cause thick walled sinuses, or the partitioning of the joint by firm adhesions. By the more vehement writers their use has been denounced as criminal by others as unnecessary. Dr Russell A. Hibbs, late chief surgeon of this hospital, always maintained that it was the pus which destroyed the tissues in such a joint that the obvious treatment was to evacuate this by the most effective possible means and that a properly used drain instead of damaging the joint, was the simplest and most efficient means of obtaining such a result.

During the World War, Willems, a Belgian army surgeon introduced a method for treating suppurating joints following penetrating wounds, which was hailed by many as revolutionary, and as "the most valuable acquisition which the surgery of the war has given us (Cohn). The principles of this method were (a) wide arthrotomy, followed by (b) immediate, prolonged, full active motion and (c) walking on the affected limb as soon as the patient's temperature fell below 100 degrees F. Some observers reported that pus was actually squirted out of the wounds at each step when Willems patients walked. The treatment was calculated to cause thorough drainage of the pus



Fig. 1. Suppurative arthritis of right hip before operation. Marked effusion, no bone destruction. Duration of symptoms, 8 days. (Case 1 Table I)

by the active motion and weight bearing and it apparently was successful in some cases. The stoicism required of a patient in undergoing this method of treatment is, however, not common in peace time civil populations, as is shown in the case reports which have appeared in the literature. Willems himself, in his original report listed three ankyloses and one secondary resection in eleven purulent knees treated by his method, 36 per cent failures. This is somewhat better than the results obtained by other surgeons who have made case reports. For example, Depage and Delray had 42 per cent failures in 31 cases, Everidge had 60 per cent failures in 20 cases, Duval had 40 per cent failures in 5 cases, Cotte had 100 per cent failures in 8 cases, Cotton had 100 per cent failures in 2 cases.

Launay however, had 2 "successes" in 2 cases. No other case reports have been found in the literature. Desgouttes and Duguet, two contemporary French surgeons, report no cases of their own, but agree that the Willems treatment, unnecessary in mild cases, is impossible and contra indicated in severe ones. The last named author advises resection for a purulent joint, and sums up the modern French attitude by saying "In these grave arthritides cure is only obtained by ankylosis, and it is exactly this which one obtains by resection. The functional point of view should not be considered." For "mild" cases he recommends arthrotomy and drainage, followed by immobilization and vaccine therapy.



Fig. 2. Same case as in Figure 1, 5 days after operation. Note rubber tube drain extending to capsule. The rubber dam drain which extends into the joint can be seen in the X-ray negative, but does not show up in the print.

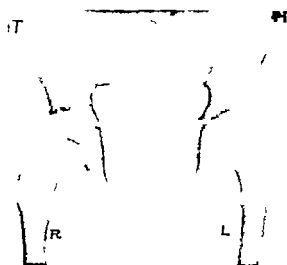


Fig. 3. Same case as in Figures 1 and 2, 4 years after operation. Except for slight corac magna and the small sclerum deposit in the soft tissues, it is now a normal hip. No limitation of motion, no symptoms, a 4-4-4 result.



Fig. 4. Suppurative arthritis of right hip, complicated by osteomyelitis of femoral neck and head, duration of symptoms 49 days before coming to hospital. (Case 31, Table I.)



Fig. 5. Same case as in Figure 4, 3 1/2 years after arthrocentesis and drainage showing mediocre result which is due to previous bone destruction. A 3-4-3 result was obtained.

The Willems treatment has met varied reception in this country. In some medical schools it is taught exclusively. However, Caldwell, among others, has decried its use, and in 1925 Blake laid down much more conservative principles for the treatment of pyogenic joints. The latter author likened suppurative arthritis to suppurative peritonitis and suppurative pleurisy, and stated:

"In both instances, if opened and drained in the early stages, the outcome is often bad, but if treated by the closed method (i.e., repeated aspiration) the results are far better. Aspiration should be repeated until resolution occurs or one becomes convinced that the destruction of tissue, such as cartilage, has taken place, when incision and drainage become necessary." Blake states that this method is particularly applicable to streptococcus infections, and rarely, if ever, to those in which the staphylococcus is involved. He makes no case reports. At the present time most surgeons would probably agree that what ever may be the possibilities of aspiration in streptococcus infection, a joint with pus in it should have an early diagnosis and early arthrotomy. Destruction of cartilage should thus be obviated rather than waited for.

Chemical disinfection following arthrotomy still has its adherents and mercuric chloride (Cotton), ether (Duguet), Dakin's solution (Cotton), and Chlumsky's solution (Kortzeborn) have been advocated for this purpose within fairly recent times. Several French authors (Lapointe and Bazy, Mirailhé, Thiféry, Wiert) have reported 'cures' of suppurating joints by the injection of bacteriophage without arthrotomy. One of these claims the singular good fortune of "curing" a streptococcus suppurative arthritis by injecting a *staphylococcus* bacteriophage into the joint. Such results have not been substantiated by others.

Most of the literature on acute suppurative arthritis is worthless because of the prevalence of opinions based upon theory, and the surprising meagerness of accurate, detailed case reports. Even when cases are reported, the so called "successes or cures" or "perfect results" are often meaningless because these terms are not defined by the author. A knee joint with 10 degrees of motion left in it may be a "success" to one surgeon but by another it would be considered a poor result. The important question of the bacteriology of the cases is rarely discussed, unless it is to say that some were due to the gonococcus, which fact alone should be enough to eliminate such cases from a study of suppurative arthritis.

A series of cases reported by Kortzeborn and Hesse, in 1931, from the Leipzig clinic, con-

stitutes the largest and most completely worked up series found in the literature. These authors prefer to treat a purulent joint by aspiration, injection of Chlumsky's solution, and early motion, although their results in 19 joints so treated were good function in 4, or 21 per cent, fair function in 4, ankylosis in 5, or 26 per cent, and death in 5 (26 per cent). Cause of death was sepsis in 2 cases, pyæmia in 1, marasmus in 2.

Fourteen of their cases were comparable to those we are about to report, i.e., cases uncomplicated by penetrating wounds or bone injury, treated by arthrotomy and drainage. Their results were unbelievably bad, there being in 14 cases, 1 death, 1 amputation, 8 bony and 2 fibrous ankyloses, only 2 cases retained partial function. These authors are thus forced to the dismal conclusion that "in all joint suppurations which necessitate a wide opening, one must give up all thought of preserving function." They refrain from using the Willems method because of its inhumanity and the impossibility of carrying it out. The knee was the joint most frequently involved, the staphylococcus the most frequent causative organism. This bacterium was responsible for 7 of their 11 deaths, but the greater percentage of ankyloses occurred with the streptococcus. 45 per cent of the streptococcus cases showed ankylosis, whereas only 25 per cent of the staphylococcus cases in which death did not occur showed this result.

PROBLEMS OF TREATMENT

After a study of the literature on the subject one therefore is left in a dilemma regarding four major problems in the treatment of acute suppurative arthritis:

- 1 Should a purulent joint be promptly incised, or should it be repeatedly aspirated until cured?
- 2 Should a joint which has been incised have a drain inserted, to ensure the maintenance of an issue for the exudate?
- 3 Does complete rest and immobilization offer a better chance for restoration of function than immediate, forced, and prolonged active motion?
- 4 Does lavage with chemical or biological products offer any hope in the treatment of a purulent joint, with or without incision?

It is hoped that the results obtained in the following series of cases will help to answer these problems.

REPORT OF CASES

In the past fifteen years operations have been performed in this hospital in 36 cases of acute suppurative arthritis.

TABLE I
Group One

None seen Age	Time affected Duration of disease Time from onset to operation in days	Time of infection? Temperature White blood cells	Operations, type of drainage	Culture	Menses begin	Drain removed Length before up	End Results	
1 B M 3 yrs	11 yrs 3	11 T 101 W B C 14,000 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 14,000 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, fatigue. No headaches. No symptoms 4	Functional Walks with no limp, ex- tremities the same, no distention, no adduction, 11. Internal rotation is normal, rotation to 4
2 C M 3 yrs	11 yrs —	11 T 101 W B C 6,900 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 6,900 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, etc., or fatigue 1 day time 4	Menses in left hip same as on right. No limp 4
3 A D M 6 mos	11 yrs 14	11 T 101 W B C 6,900 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 6,900 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, fatigue. No headaches. No symptoms 4	Walks with slight limp. No limp to shortening. No distention, no adduction, 11. Internal rotation is normal, rotation to 4
4 A O M 3 yrs	11 yrs 14	11 T 101 W B C 6,900 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 6,900 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, fatigue. No headaches. No symptoms 4	Walks with slight limp. No limp to shortening. No distention, no adduction, 11. Internal rotation is normal, rotation to 4
5 O M 6 mos	11 yrs 14	11 T 101 W B C 6,900 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 6,900 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, fatigue. No headaches. No symptoms 4	Walks with slight limp. No limp to shortening. No distention, no adduction, 11. Internal rotation is normal, rotation to 4
6 A W K M 12 yrs	11 yrs 3	11 T 101 W B C 6,900 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 6,900 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, fatigue. No headaches. No symptoms 4	Menses exaggerated in all directions. In- correct 4
7 A L M 12 yrs	11 yrs 3	11 T 101 W B C 6,900 14%	Posterior drainage Rubber tube drain entered in Traction 1 1/2 cm Chick, cranney pen	11 T 101 W B C 6,900 14%	Prems on not active or 7th	4th day — yes	Asymptomatic No pain, stiffness, fatigue. No headaches. No symptoms 4	Menses exaggerated in all directions. In- correct 4

TABLE I—Continued
Group One—Continued

Name Sex Age	Joint affected Duration of symptoms before operation in days	Foci of infection? Temperature White blood cells	Operations, type of drainage	Culture	Motion began	Drain removed Length of follow-up	End-Results		
							Anatomical	Symptomatic	Functional
8. J. M. M. 14 yrs	11/11/11 7	Outbreak of T. 101 W.B.C. 10,700 75%	Aspiration, then posterior incision. Rubber tube served into joint 31 cm thick pus	Staphy- lococcus	Positive and active be- fore 4th day	17th day 5 yrs	Normal hip clinically and by X-ray	No pain, ache, stiffness, even in bad weather. Walks in stairs without pain or fatigue	Extension 180 flexion 40 abduction 90, adduction 30 internal rotation 45 external rotation 45 Walks with slight limp due to shortening in opposite femur
9. I. S. J. M. 11 yrs	11/11/11 9	Outbreak of r T. 101 W.B.C. 3,000, 85%	Posterior incision. Rubber tube into joint 10 cm gray fluid	Staphy- lococcus aureus	Pain + in- tensity active on 4th	13th day 5 yrs	Normal hip clinically and by X-ray	No symptoms of any kind at any time. Is on his school track team	Extension 180 flexion 30 abduction 90 adduction 45 external rotation 60 internal rotation 45 no limp
10. P. T. M. 4 yrs	11/11/11 30	Local pneumonia 6 weeks before T. 90.4 W.B.C. 14,000, 68%	Posterior drainage. Rubber tube into joint. 8 oz of thick yellow pus. Traction	Pneumo- coccus	?	11st day 1 yr	Normal hip clinically and by X-ray	No symptoms at any time Had erysipelas after operation, recovered	No limp Motion normal in all directions
11. J. C. M. 8 yrs	11/11/11 14	Infected operative wound, tumor re- moved from pre- patellar region. 1 month before T. 101 W.B.C. 30,000, 75%	Incision on each side of patella. Rubber drain served into each Traction. Small amount of thick pus	Bacillus Pro- coccus	?	? 4 1/2 yrs	Normal knee except for slight tenderness of anterior cord by X-ray	Very active. No symp- toms at any time	N limp Extension 180, flexion 30 No rota- tion
12. W. O. M. 6 yrs	11/11/11 3	Hemolytic strep- tococcus erysi- pelas nasal discharges T. 101 W.B.C. 11,950, 65%	Incision on each side of patella. Rubber drain served into each joint. Joint distended with pus	Hemolytic strep- tococcus	Moved to anesthesia at 6 weeks	? 6 yrs	Hip 5 degrees flexion X-ray, but no de- formity	Very active. No symptoms	Extension 175, flexion 100 Slight limp
13. A. G. M. 3 yrs	11/11/11 23	Fungal carnal T. 100.4 W.B.C. 9,000 64%	Incision on each side of patella. Rubber tube drain into each. 2 oz than pus	Hemolytic strep- tococcus	?	? 9 yrs	Knee appears normal by X-ray, but has de- gree flexion deformity	Occasionally complaint of slight pain, but with will and is very active	Extension 170, flexion 30. Slight limp
14. A. S. M. 6 yrs	11/11/11 14	Struck on knee by T. 101 W.B.C. 10,500, 85%	Incision on each side of patella. Rubber drain served in Traction. Thin yellow pus	Non-hemo- lytic strep- tococcus	Moved to anesthesia on 15th day	? 3 yrs	X-ray shows overdeveloped condyles and joint space slightly thinned, 35 mm lengthening of ef- fect leg. Flexion deformity of 15 degrees	Down all symptoms. Bad weather and decrease have no effect	N limp or stump. Extension 165, flexion 35

TABLE I—Continued
Group One—Continued

Name Sex Age	Lesion affected Duration of operation in days	Foci of infection? Tubercles in bone blood cells	Operation, type of drainage	Culture	Motion before	Dress removed Length of follow up	Lesion Number		
							Anatomical	By symptoms	Functional
1 D V M 12 yr	1 day — W B C 1,000, 10%	Yes	Abscess followed by partial amputation from deep-seated foci	Staphy- lococcus and strep- toccus	Passive on 1st day	6th day — 4 yr	X-ray shows slight over- extension of scapula sternum normal No bone density No thickening of affected lig.	No pain, fatigue, or other symptoms in last year or after anesthesia	No limp or pain Motion same as in other limbs, extension 180 degrees
16 C B F 17 yr	1 day — W B C 4,000, 10%	Yes	Medial and lateral abs- cesses. Thick pus Through-and through rubber drain drain	Staphy- lococcus cocci	Passive on 1st day active on 4th	6th day — 1 yr	11 inch shortness. Right normal extension of medial rotation	No symptoms except deep venal thrombosis on 2nd day. Pains present all day without fatigue or fever	No limp. Motion 180-190 degrees. On right 18 and 115 degrees
17 A P M 17 yr	1 day — W B C 4,000, 10%	Yes	Lateral abscess. Thin viscous pus. Rubber drain drain	Non-hemo- lytic strep- toccus	?	10th day — 14 yr	Ankle normal clinically and by X-ray	No symptoms even in bad weather. Pains and ven- ous thrombosis	Extension 115 degrees No restriction
18 E G F 15 yr	1 day — W B C 4,000, 10%	Yes	Abscess followed by partial amputation from deep-seated foci. Thin pus. Rubber drain drain	Staphy- lococcus cocci and strep- toccus	?	1st day — 116 yr	Normal clinically. X-ray normal except for slight enlargement of lower end of humerus	No symptoms even in bad weather. Pains all games without handicap	Extension 180 degrees Normal pronation and supination. Carrying single normal
19 R M F 17 yr	1 day — W B C 1,000, 10%	Yes	Abscess, repeated 3 days later. Five cm. abs- cess. Thick pus. Rubber drain drain	Staphy- lococcus cocci	Passive on 1st day active on 4th	6 yr	Normal elbow. X-ray shows very slight thick- ening of humerus	No symptoms at any time	Normal motion just as in opposite elbow
20 O O M 17 yr	1 day — W B C 1,000, 10%	Yes	Abscess, thin perfor- ated, incision. Rubber drain drain. 1 cm. thin green pus	Staphy- lococcus cocci and strep- toccus	Active on 4th day	1st day — 8 yr	Normal clinically and by X-ray. No thickening	No symptoms even in bad weather. Full use of arm.	Extension 180 degrees Supination and pron- ation normal, carry 100 pounds
21 S M F 17 yr	1 day — W B C 1,000, 10%	Yes	Partial infection on superficial foci Abscess point pack	Staphy- lococcus cocci	Active on 1st day	1st day — 14 yr	11 inch shortness. Right normal extension of medial rotation	No symptoms even in bad weather. Pains and ven- ous thrombosis	Extension 115 degrees No restriction
22 J R F 17 yr	1 day — W B C 1,000, 10%	Yes	Abscess, thin, perfor- ated, incision. Rubber drain drain. 1 cm. thin green pus	Staphy- lococcus cocci and strep- toccus	Active on 1st day	1st day — 14 yr	11 inch shortness. Right normal extension of medial rotation	No symptoms even in bad weather. Pains and ven- ous thrombosis	Extension 115 degrees No restriction

TABLE I—Continued
Group Two

Name Sex Age	Joint affected	Face of infection Transmit Temperature White blood cells	Operation, type of drainage	Culture	Motion began	Deals removed — Length follow-up	Anatomical	Symptomatic	End-Results	Functional
H R 13 3 mos.	Knee, L 90	No larvae seen W B C 15,000, 57%	One incision medial to patella. Rubber drain into joint as thin	No growth	?	3rd day 1 ym.	1/4 inch shortening. Light Pain. No tenderness or looseness of no degrees	No pain at any time Plays all games	End Results	Boony ankylosis
M 14 1 ym.	Knee, L 30	Optical thromb W B C 15,000 75%	Small incisions with rubber drain. Four days later incisions enlarged and Dala tubes in- serted. Much thick pus aspirated. Then posterior incision. Drainage tube into joint 1 or 2 in. Pus	No growth	Active before 14th day	Daily re- stitutions 3rd day	Small ankylosis in ex- tremity. 1/4 inch shortening	No pain at any time	Motion 140-20 degrees, stopped by fear from old operation fracture N limp	
H E 13 3 ym.	Hip, L 0	Tonsils removed 3 weeks ago W B C ?	Apertures, then posterior incision. Drainage tube into joint 1 or 2 in. Pus	Pus taken 3 or 4 times	?	1st day 3 ym.	Normal ankylosis. No shortening. 1/4-1/2 inches normal joint ex- cept for slight change time of neck	No pain at any time Very active child	Normal motion in all directions, same as la- ter. Opposite hip. No limp	
H E 13 3 ym.	Hip, R 4	Tonsils with thick pus W B C 40,000 per	Posterior incision 5 or 6 in. Thick pus. Glycerine drain 1/2 in.	No growth in 72 hours	?	?	Had osteomyelitis of removed head, with infection. 1/4 inch short	Braces for 3 years emphyseal water	Had osteomyelitis of removed head, with infection. 1/4 inch short	Very free motion in all directions. Stable. Good operation advised, but refused. Discharged

Group Three

Name Sex Age	Joint affected — Duration Time from onset to operation in days	Food of infection? Trauma? Tinea? Tubercle? White blood cells	How inverted, turned out, ectropion ectropion?	Operation (Antiseptics) Type of drainage	Subsequent operations	Culture — Length of follow-up	End Results		
							Anatomical	Symptomatic	Functional
W.C.B. F 3 yrs	Hip, R. — 40	Males 101 W.B.C. 8,600, 66%	Fester and scabrous at time of operation	Anterior incision 1000 cm. x 1 1/2 in., creasy pus at time of operation drainage, not into joint (?) Traction	0 subsequent incisions with drainage of large abscess Hip became satisfactory	Hemolytic streptococcus 15 yrs	Hip satisfactory no ankylosis General health excellent	No symptoms Last year 1 year ago (General health excellent)	Active. Walks with almost no limp
M.R. F 4 yrs.	Hip, L. — 50	Septicemia after transfusion	Fester and scabrous Fester dis- charged abscesses subincision	Posterior incision Femoral Head well disinfected by antiseptic Traction not incised Traction	None	"Staphy- lococcus" 3 yrs	No pain or swelling General health good, though ear still drains	No pain or swelling General health excellent	Freedom to sit on floor No ankylosis No anesthesia 15. Mod- erate left limp. Hip stable
R.D. F 8 mo.	Hip, R. — 7	Tooth enlarged. 10 W.B.C. 17,400 65%	Fester Fes- ter and scabrous Fester abscess operation	Posterior incision. Rubber tube drains. Greyish yellow pus	None	Non-hemo- lytic strep- tococcus 2 1/2 yrs	Hip still dislocated when last seen applied	No pain, no drainage Walks with hip applied	Hip pull dislocated. Salvage opera- tion advised

TABLE 1--Continued
Group One--Continued

Case	Sex	Age	History of disease	Operation	Culture	Median length	Days required to lay-up	Antitoxin	Symptoms	Functional
101	Male	3 yrs	History of disease: T. 101, W B C 12,000, 85%	Agarose, 100% T. 101, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 101, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
102	Male	3 yrs	History of disease: T. 102, W B C 12,000, 85%	Agarose, 100% T. 102, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 102, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
103	Male	3 yrs	History of disease: T. 103, W B C 12,000, 85%	Agarose, 100% T. 103, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 103, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
104	Male	3 yrs	History of disease: T. 104, W B C 12,000, 85%	Agarose, 100% T. 104, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 104, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
105	Male	3 yrs	History of disease: T. 105, W B C 12,000, 85%	Agarose, 100% T. 105, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 105, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
106	Male	3 yrs	History of disease: T. 106, W B C 12,000, 85%	Agarose, 100% T. 106, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 106, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
107	Male	3 yrs	History of disease: T. 107, W B C 12,000, 85%	Agarose, 100% T. 107, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 107, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
108	Male	3 yrs	History of disease: T. 108, W B C 12,000, 85%	Agarose, 100% T. 108, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 108, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
109	Male	3 yrs	History of disease: T. 109, W B C 12,000, 85%	Agarose, 100% T. 109, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 109, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms
110	Male	3 yrs	History of disease: T. 110, W B C 12,000, 85%	Agarose, 100% T. 110, W B C 12,000, 85%	Staphylococcus aureus	100 mm	100 days	Agarose, 100% T. 110, W B C 12,000, 85%	No pain, itching, or other symptoms	No pain, itching, or other symptoms

TABLE 1.—Continued
Group Three—Continued

Name Sex Age	Lesion Duration of symptoms before operation (in yrs)	Foci of infection? Tissue? T? W B C No. per field (before op.)	Focus of abscess (or of pus) after operation?	(Abscess Anatomical) Type of abscess	Subsequent operation	Lesion Length of cure (in yrs)	End results	
							Anatomical	Functional
30 K O F 3 yrs	High L —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Posterior abscess and rubber dam not limited partial fluid	No operation of any kind. Had no contact with bag	8 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain
D H M 3 yrs	High R —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Anterior abscess. Large abscess. This reached fluid level. Rubber dam traction	Had another incision and drainage. No rubber dam traction	8 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain
31 B L M 4 yrs	High L —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Anterior abscess. This reached fluid level. Rubber dam traction	Subsequent opera- tion. Posterior abscess. Third opera- tion. Rubber dam traction	4 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain
32 T O F 3 yrs	High L —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Anterior and posterior abscess. This reached fluid level. Rubber dam traction	Subsequent opera- tion. Posterior abscess. Third opera- tion. Rubber dam traction	4 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain
33 H S M 6 mos	High R —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Posterior abscess. This reached fluid level. Rubber dam traction	Subsequent opera- tion. Posterior abscess. Third opera- tion. Rubber dam traction	4 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain
34 B T F 3 yrs	High R —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Posterior abscess. This reached fluid level. Rubber dam traction	Subsequent opera- tion. Posterior abscess. Third opera- tion. Rubber dam traction	4 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain
35 W Y F 7 yrs	High L —	Pre-op W B C 14,000, 80% T 0	Pre-op W B C 14,000, 80% T 0	Posterior abscess. This reached fluid level. Rubber dam traction	Subsequent opera- tion. Posterior abscess. Third opera- tion. Rubber dam traction	4 yrs	No pain, no discharge. No abscess or other lesion. No contact with bag No pain	Normal No pain, no discharge. No abscess or other lesion. No contact with bag No pain

In order to clarify the study, the cases have been divided into three groups, as follows

Group 1 consists of 22 cases which were bacteriologically proved and which were not complicated by bone infection. This group constitutes the main series upon which this study is based.

Group 2 consists of 4 cases similar in every way to the above except that they were not bacteriologically proved.

Group 3 consists of 10 cases, all proved bacteriologically but which were complicated by osteomyelitis at the joint.

Group 1

Twenty two cases, bacteriologically proved uncomplicated

Incidence There were 5 females and 17 males, a ratio of 1 to 3.4. Age at operation ranged from 6 months to 14 years (except for one male of 32), averaging 6.5 years. The disease is thus essentially one of childhood

The hip was affected in 10 cases, or 45.5 per cent the knee in 6 or 27 per cent. There were 3 elbows, 2 ankles, and 1 shoulder

Etiology With one exception (Case 11 Table I), all the infections in this group were of metastatic hematogenous origin. The etiology of such infections can rarely be definitely established. A history of definite trauma was obtained from 5 patients and in 15 or 68 per cent of the group there was evidence of foci of infection which might have had a causal relationship. Only two patients had neither focus of infection nor trauma. The foci of infection encountered, in the order of their frequency were infected tonsils, chronic osteomyelitis in a distant bone (i.e. a bone not entering into the formation of the affected joint) otitis media pyelitis septicæmia purulent cervical adenitis, pneumonia.

Symptoms and physical signs did not differ, in this series, from the usual textbook descriptions. The most constant symptoms were pain and inability to use the affected joint, with swelling in all cases except some of those in which the hip was affected. Varying degrees of general reaction were present, from high fever and prostration to moderate pyrexia and malaise. The duration of symptoms before operation varied between 2 and 28 days averaging 9 days. Often the patient had been treated at home during these important days without a correct diagnosis.

The temperature per rectum ranged from 99.4 to 105 degrees F., the mean temperature on admission being 102 degrees. The white blood cell count was listed as low as 6,800 and as high as 52,800 with a mean of 16,800. The mean per

centage of polymorphonuclear leucocytes was 72.0 per cent.

Roentgenograms strongly suggested pyarthrosis in 9 cases, in 7 cases the evidence from this source was less helpful, while 6 patients had no pre-operative roentgenogram

Diagnosis This is more difficult than one is led to believe. Especially is there difficulty in the differential diagnosis between this condition and (a) joint tuberculosis, (b) acute rheumatic fever, (c) sympathetic sterile effusion into a joint near infected area, as osteomyelitis or cellulitis, (d) acute non-suppurative infectious synovitis.

There is no single test for joint suppuration. The history, physical examination, clinical laboratory reports, and roentgenograms must all be carefully studied, and observation in the hospital for a day or two may be necessary to arrive at a diagnosis. It is probably less serious to open a sterile joint than to fail to open a purulent one although in the presence of surrounding inflammation the most acute surgical judgment is needed to make such a decision. *Aspiration* of the exudate for the purpose of diagnosis is invaluable. This should be performed in every case in which there is any doubt about the diagnosis, smears and cultures being made immediately, even if both of these are negative however arthrotomy should be performed if the clinical and roentgenographic signs are sufficiently suggestive of suppuration

The positive diagnosis of pyarthrosis cannot be made in the early stages from the roentgenogram alone, but when an effusion, the density of which is consistent with pus, is seen in a joint having the necessary history and physical signs, that diagnosis is strongly suggested.

Operation In 20 patients of Group 1 the purulent joint was treated by wide arthrotomy, and a drain was placed into the joint cavity in each case to ensure continued evacuation of the pus. The material used for these intracapsular drains was soft rubber dam or soft gutter tubing heavy walled rubber tubes were placed down to capsule when necessary to preserve a drainage tract through thick muscle layers as at the hip. All drains were usually sutured in place. At the knee, the rubber dam drain was often placed completely through the joint, traversing the suprapatellar pouch

Incisions were placed in dependent situations when the anatomy of the joint made this feasible e.g. posteriorly at the hip (except in 2 cases) and shoulder, posterolaterally at the elbow at the knee two longitudinal incisions were made, one on each side of the patella.

In the 2 remaining joints of Group 1 arthrotomy was not performed for the reason that the diagnostic aspiration of pus was followed by rapid unexpected, and complete resolution of the infection. They were undoubtedly infections with attenuated organisms one an elbow from which *Staphylococcus aureus* was cultured, the other a pneumococcal infection of the knee (Cases 19 and 22). The diagnostic paracentesis had no such effect in the remaining cases.

Pathology. Every joint in this series was a definitely purulent one when opened. In all cases pus was encountered varying in consistency from thin gray seropurulent exudate to thick, yellow creamy pus. The synovial membrane was usually severely injected and hypertrophied, with more or less necrosis; the capsule and peri-articular structures were usually described as oedematous. Granulation tissue in many instances encroached upon the articular cartilage, but in every case in this group in which the operative note described it, the cartilage itself was said to be intact.

In no case in Group 1 was there any destruction of bone, either before the arthrotomy, or subsequent to it. Nor was there any case of phlegmon extending from the joint through the fascial planes of the extremity.

Microscopic sections were made in only 6 cases. It has been the feeling in this hospital that the arthrotomy in a purulent joint should be done as quickly as possible with no unnecessary opening up of new tissue spaces to the infection. Hence the paucity of material for microscopic study.

The sections which were made confirm the already well known pathological picture: a synovial membrane thickened by oedema, hypertrophy and hyperplasia, these processes extending also into the subsynovial areolar tissues to varying extents; synovial membrane and underlying tissue densely infiltrated with polymorphonuclear leucocytes, and more or less extensive necrosis of the superficial layers of synovial membrane.

Bacteriology. Positive cultures were obtained from all the joints in Group 1. The organisms encountered in the order of their frequency were

	Cases	Per cent
<i>Staphylococcus aureus</i>	7	32
Hæmolytic streptococcus	4	18
Non-hæmolytic streptococcus	3	14
<i>Staphylococcus</i> plus streptococcus	3	14
Pneumococcus	3	14
* <i>Staphylococcus</i> (anxiety not stated)		4.5
<i>Bacillus pyocyaneus</i>	1	4.5

The *Bacillus pyocyaneus* is not common in this disease. In this case an operation on the prepa-

tellar region performed at another hospital, resulted in a *Bacillus pyocyaneus* infection, and the patient was brought to us after the knee became involved (Case 11).

The virulence of these organisms and the results obtained in joints infected with each, will be discussed presently.

Complications. The complications usually spoken of in treatises on acute suppurative arthritis are septicæmia, osteomyelitis, phlegmon, ankylosis, amputation death. None of these untoward events occurred in any case in Groups 1 and 2 of this series. One patient (Case 21) with a purulent shoulder had several recurrences requiring arthrotomy; another had a pathological dislocation of the hip. There were no other serious complications.

Postoperative treatment. Motion. Gentle passive motion was instituted immediately after the operation and this was replaced by active motion as quickly as the patient was able to bear it. The average time at which active motion was begun was 2.5 days after operation, although records of this were not kept on all of the charts. In 2 cases (12 and 14) the arthrotomized knee had to be moved under anaesthesia at 6 weeks and 12 days, respectively because of stiffness. Both of these patients obtained good, but not excellent, results.

Removal of drains depended upon the decrease in drainage and the patient's temperature. The rule was gradually to withdraw the drain as fast as the subsidence of the infection would allow. Complete removal usually occurred between the seventh and twenty first days, though it varied between the first and the fortieth days after operation. Dakin irrigations were used in 1 case.

Traction was used in 10 of the 18 cases of lower extremity involvement. 8 hips and 2 knees were thus treated. No figures were available as to how long the traction was maintained.

Weight-bearing was not forced. The earliest day on which walking was begun in a lower extremity case was the twenty-eighth day after operation and the average was 45 days. The date was determined by the general condition of the patient and the appearance of the joint.

Results of the operations. All but 9 of the patients were seen and examined by the authors in the follow up clinic, and their condition at the time determined as accurately as possible. When it was impossible to get a patient in for examination, his condition was estimated from the most recent notes on his history.

The length of time elapsed between operation and final follow up examination for this group averaged 4.3 years, there being only 1 case with a

follow up of less than 1 year and the longest period being 14 years.

The result of the treatment in each case was evaluated according to the anatomical symptomatic and functional condition of the joint at the time of last examination, the degree of success obtained by the operation was indicated numerically from 0 to 4 in each of the named categories of anatomy symptoms, and function 0, representing a failure, 1, a poor result 2, fair 3 good, and 4 an excellent result. This system of follow up evaluation was originated at the Presbyterian Hospital in New York City in 1914, and was described in *The Medical and Surgical Reports* of that institution in 1918 by Dr James A. Corscaden. According to this system an excellent result is designated an anatomical 4, symptomatic 4, functional 4, or more simply as 4-4-4, a complete failure would be 0-0-0. A patient who had a good anatomical excellent symptomatic but poor functional result would be classed 3-4-1.

In estimating the anatomical result of the operations, account was taken of such variations from the normal as shortening atrophy bone destruction, relaxation subluxation, dislocation, flexion deformity, and ankylosis. For the symptomatic result, the patient's complaints of pain, stiffness, lump, and fatigue were weighed. To determine the functional or economic result a careful study was made of the exact range of motion at the joint, these measurements being made personally by the authors in most of the cases, also the gait the handicap in work or athletics, the ability to execute skilled movements were studied.

The personal judgment of the authors was necessarily called into play in arriving at the numerical classification of these cases, particularly of those not examined personally in the follow up clinic. If there was any difficulty in estimating any phase of a result, the classification was purposely made to err toward the lower rating. If ankylosis occurred in any joint it was considered an anatomical as well as a functional failure. Table I gives a short résumé of every case in the series, with its anatomical, symptomatic and functional result and the numerical classification.

Of the 22 patients in Group 1 there were 12 or 54 per cent in whom the anatomical symptomatic and functional results were all excellent, i.e., 4-4-4 results or joints restored practically to normal. These patients have little if any residual of the disease apparent in the roentgenogram no pain stiffness, or lump and no limitation of motion or activity.

In addition to these 12 excellent results, there were 5, or 23 per cent, in whom good results were obtained, viz one 3-4-4, two 3-4-3's, one 3-3-3, one 2-4-4. One result was fair, a 3-4-2, and 2, or 9 per cent of the group, were listed as poor, one of the latter was a 0-0-0 because of a pathological dislocation which the patient refused to have treated (Case 5), and the other was a 3-0-0 a patient with numerous recurrences, who finally disappeared, still in need of another operation (Case 21).

Two patients in this group could not be classified because of insufficient data.

The average duration of symptoms before operation in the excellent results was 7 1/2 days, the majority being less than 5 days for the good and fair results the average was 12 days. The one poor result in which the duration was certain had had symptoms for only 3 days.

The postoperative temperature reached normal in from 4 to 33 days averaging 15. The average time required for the healing of the wounds was 48 days.

Group 2

Four cases, not proved bacteriologically, un complicated.

These cases differ from those in Group 1 in no way except that the causative bacterium was not determined. In 3 cultures were taken at the time of arthrotomy and no growth occurred in the other, there is no record of a culture having reached the laboratory. Clinically and pathologically they were typical cases of acute suppurative arthritis without involvement of the bone.

The mean temperature and blood count, and the operative procedure were approximately the same as in the previous group. Drains were used in each case and in each joint pus was found. The follow up averaged 7 1/2 years, ranging between 5 and 11 years. Two hips and two knees were involved.

The outcome in these cases was 4-4-4 in 2, 0-4-0 in 1, and 1-0-1 in 1, or, two excellent and two poor results.

Group 3

Ten cases bacteriologically proved, with bone involvement.

The hip was the joint affected in every case in this group. The bone infection was an acute osteomyelitis of the femur or acetabulum or both present at the time of admission to the hospital, in no case was there a focus of chronic osteomyelitis in another bone.

TABLE II.—END-RESULTS ACCORDING TO GROUPS

End Result	Group 1	Group 2	Group 3
4-4-4	18	2	
3-4-4	1		
3-4-3	2		2
3-4-2	1		1
3-3-3	1		
3-4-4			
3-4-3			1
3-3-3			
1-2-0			1
0-4-0		1	1
0-3-0			1
3-0-0			
0-3-0	1		1
Unclassifiable	2	1	
Total No of Cases	22	4	10

The average age of this group was 57 years, and the average duration of symptoms before operation was 49 days (in Group 1 it was 9 days) exclusive of one patient who had been treated in another hospital in a spica, without operation, for 200 days.

Symptoms, physical signs, temperature, and blood counts did not differ materially from the cases in Group 1.

The causative organisms were staphylococcus in 4 cases, streptococcus in 4, mixed staphylococcus and streptococcus in 1 and mixed streptococcus and *Bacillus coli* in 1.

The arthrotomy and insertion of drain in this group had to be followed in all but 2 cases by subsequent operations for the removal of sequestra, partial osteotomy or to widen the drainage tract. Hence the pathology and the postoperative course were somewhat different from the cases in Group 1. It was impossible to say whether the osteomyelitis or the arthritis was the original lesion in these cases; there is little doubt, however, that an undiagnosed, untreated pyarthrosis at the hip could be expected to cause bone infection sooner or later.

Traction was used in 6 of these cases and a plaster spica in 1. Attempts to establish motion met with much less success than in the uncomplicated cases. The removal of drains, healing of sinuses, and length of stay in bed were determined by the progress of the osteomyelitis rather than by the joint infection.

The follow-up period for this group averaged 7 years. Among the 10 cases there were no excellent results, although 6 patients were completely relieved of symptoms. 4 results may be called good (Cases 30, 31, 32, 34), 1 poor (Case 28) while 5 were failures. Four of the failures were due to ankylosis, 1 to an irreducible dislocation which was present on admission. There were no deaths,

amputations, or cases of septicemia; the one phlegmonous abscess was present on admission in the patient (Case 33) who had lain 200 days in a spica in another hospital, and was undoubtedly due to the long delayed operation.

Thus 50 per cent of the cases in this group resulted in failures with no excellent results. When the outcome of these cases is compared with that of the cases in Group 1, it is seen that the presence of bone infection as a complication of purulent arthritis greatly increases the seriousness of the disease, and renders the prognosis for function much less sanguine. Table II shows graphically the results in each group.

FACTORS INFLUENCING FINAL RESULTS

The results of the treatment in this series of cases are surprisingly good when compared with the case reports in the literature. The factors which may have some bearing on this difference will be discussed under the following headings:

1. *Virulence of the infection.* There were of course, wide variations in the virulence of the infecting bacteria, as is shown by the fact that one patient with a *Staphylococcus aureus* infection of the knee recovered after simple aspiration, whereas others with the same organism were prostrated with a very severe infection and ended with poor joints in spite of early and efficient treatment. Low virulence of the bacteria may account for some of the excellent results obtained in this series, but that it cannot account for all of them will be evident to one who studies the figures for temperature and blood counts given in Table I. It may not be unusual to see a joint infected with the pneumococcus get well with aspiration, but this must certainly be an unusual event with the staphylococcus. The authors can not speak with experience about the result of aspiration as the sole method of treating streptococcus pyarthroses. Table III shows the end-results of the cases in Group 1 arranged according to the infecting organism.

2. *Early diagnosis and arthrotomy.* There was little temporizing with purulent joints in this series. Arthrotomy was performed in each case as soon as was feasible after the diagnosis was made. The only delay was in the patient getting to the hospital. The best results, in general, were obtained in those joints which had early diagnosis and early arthrotomy.

3. *The use of drains.* Far from constituting a misdemeanor it is believed that the results in this series of cases will show that the use of soft rubber drains into the joint cavity is one of the most helpful adjuncts in the treatment of pyogenic joints.

TABLE III—END-RESULTS IN GROUP I ACCORDING TO INFECTING ORGANISM

Result	4-4-4	3-4-4	3-4-3	3-4-2	3-3-3	2-4-4	3-0-0	0-4-0	Unclassifiable	Total No of cases
Staphylococcus aureus	4		1				1		2	8
Hemolytic streptococcus		1		1	1			1		4
Non-hemolytic streptococcus	1		1			1				3
Dreptococcus and staphylococcus	3									3
Pseudomonas	3									3
Bacillus pyocyaneus	1									1

TABLE IV—END-RESULTS IN GROUP I ACCORDING TO DURATION OF SYMPTOMS BEFORE OPERATION

Duration of symptoms in days

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25 plus
4-4-4	2	3	2		1		1		1					1						1					1
3-4-4									1																
3-4-3														1											
3-4-2		1																							
3-3-3																									1
2-4-4														1											
3-0-0		1																							
Unknown			1																						

In one case, the duration of symptoms was unknown

The drains must be soft, they must not be large enough to cause pressure necrosis and they should be withdrawn as rapidly after operation as the subsiding of the infection will permit.

4. *Traction* It is believed that the routine use of traction in these cases has exerted a favorable influence. Traction helps to relieve pain to prevent or overcome flexion deformities, and possibly to protect the articular cartilages if as Phemister claimed, necrosis of this tissue first occurs at points of pressure in a suppurating joint. The traction apparatus must be so applied that it will not interfere with free motion at the joint. The simplest method is by means of an anklet and a weight over a pulley at the end of the bed.

5. *Motion*. A great deal has been written in the literature about active versus passive motion, much to the discredit of the latter. It would be ideal treatment in pyogenic joints to start frequent, prolonged, and complete active motion immediately after operation, but such treatment can be attained only in rare instances. One needs only to see a single case to appreciate the suffering undergone by a patient with such a lesion, and when the average age of these patients is recalled, it becomes obvious that too much cannot be expected of active motion.

Passive motion, extremely gentle in its application, never forced in its degree, repeated several times a day by the surgeon, is much more feasible, and almost if not quite as effective as active motion in the early postoperative treatment. Each joint in this series was thus treated, and active motion substituted for passive as soon as possible. Emphasis must be placed on the *gentleness* of this passive motion. The importance of active motion cannot be overemphasized, but at the same time the usefulness of passive motion should not be overlooked.

6. *The main purpose* in the treatment of acute suppurative arthritis is, of course, the evacuation of the pus by the most efficient means possible. The use of drains and of early passive and active motion was invaluable in accomplishing this in the present series of cases and the fact that these methods when correctly used, are not destructive to infected joints is demonstrated by the end results here reported.

SUMMARY AND CONCLUSIONS

1. An historical review of the treatment of acute suppurative arthritis is presented.

2. Case reports of this disease are scarce in the literature, the results reported are usually bad,

and the attitude of the writers toward the disease is gloomy.

3. The idea of attempting to preserve the function of a purulent joint is relatively recent and is not yet widespread.

4. Thirty six cases of acute suppurative arthritis are presented, in which operations had been performed at the New York Orthopaedic Dispensary and Hospital during the past 15 years.

5. Twenty two of these cases were bacteriologically proved and uncomplicated by bone infection. The end results in this group were 12 or 54 per cent were excellent anatomically, symptomatically and functionally 5, or 23 per cent, were good 1 was fair and 2 or 9 per cent, were poor.

6. Four cases were similar to the above except that they were not bacteriologically proved. Results in this group were 2 excellent and 2 poor.

7. Ten cases were complicated by infection of the bone at the joint. The results in these were much worse than in the above groups, there being no excellent results and five failures due to ankylosis or dislocation.

8. It is thus seen that the presence of bone destruction greatly increases the seriousness of this disease.

9. The average follow up period was 6.5 years. The average age at operation was 6.5 years. There were thrice as many males as females. The hip was involved in 22 cases, the knee in 8, there were 1 elbow, 2 ankles, 1 shoulder.

10. The staphylococcus was the infecting organism in 12 cases, streptococcus in 11, mixed staphylococcus and streptococcus in 4, pneumococcus in 3, mixed streptococcus and Bacillus coli in 1, Bacillus pyocyaneus in 1.

11. In general the best results were obtained in those joints which had early diagnosis and early evacuation of the pus.

12. Active postoperative motion cannot be depended upon as the sole method of continuous evacuation of pus from an infected joint, because of the extreme pain and the usually tender age of the patient.

13. In obtaining efficient continued drainage in this series of cases the most useful adjuncts to arthrotomy were found to be the insertion of soft rubber drains into the joint cavity and gentle passive motion immediately following the operation. The importance of active motion after arthrotomy cannot be overestimated, and this was substituted for passive motion as soon as the patients could stand it.

14. There were no deaths, no amputations, no septicemias ankylosis occurred only in 4 cases

in which bone destruction at the hip had occurred before operation.

15. The prognosis for function in acute suppurative arthritis is good if the diagnosis is made early and this is promptly followed by arthrotomy and drainage. It is poor if treatment is delayed until bone destruction has taken place.

BIBLIOGRAPHY

- BLAKE, JOSEPH A. Treatment of acute pyogenic joint infections. *Am J Surg* 1925 39 81.
- BROOK, SIR BENJAMIN. Observations on Diseases of the Joints. 4th ed. London, 1840.
- CALDWELL, G. A. Treatment of acute suppurative arthritis. *South. M J* 1926, 19 637.
- CHAUVET, H. Les abcès periarthraux compliquant les arthrites purulentes du genou. *Paris méd* 19 6 225.
- COLE, J. Treatment of purulent arthritis. *New Orleans M & S J* 1924, 76 301.
- CORACADEY, JAMES A. Follow-up system of the Presbyterian Hospital. *Medical & Surgical Reports of Presbyterian Hospital in New York*, 1913, 10 53.
- COTTE, G. Quoted by Duquet.
- COTTON, F. Disinfection of septic joints. *Boston M & S J* 1916, 74 779. Infections of bones and joints. *Surg. Gynec. & Obst.*, 1921 31 254.
- DAVID, A. C. Treatment of acute suppurative arthritis of the knee joint. *Surg. Clin. Chicago*, 1920, 4 233.
- DEPAGE and DELBAY. Quoted by Duquet.
- DEMOCETTES. Quoted by Duquet.
- DEUTER, M. Etat actuel de la question du traitement des arthrites purulentes. *Arch. de méd. et pharmacol.* 1921, 78.
- DUVAL, F. Quoted by Duquet.
- EVANS, J. J. New method of treatment for suppurative arthritis of knee joint. *Brit J Surg* 19 6, 6 566. Mobilization treatment of knee-joints. *Proc. Roy. Soc. Med. (Clinical Section)* 19 9, 3 10.
- FRIEDER, A. W. Indikationen und Erfolge des geschlossenen Behandlung von Gelenkerkrankungen. *Klin. Wchnschr.* 19 3, 3 1223.
- GARDNER, F. H. An Introduction to the History of Medicine. 3d ed. Philadelphia W. B. Saunders Co. 1924.
- GRACORE, R. A. propos d'une arthrite suppurée guérie à la suite d'injections de bactériophage. *Bull. et mém. Soc. nat. de chir.* 937 57477.
- HARRIS, RUSSELL A. Unpublished paper read at New York Academy of Medicine Dec. 8, 1920.
- JONES, E. O. Observations on the treatment of septic arthritis of the knee joint. *Northwest Med* 1920, 9 286.
- KOESTER, A. and HILMAR, F. Behandlung und Endanstellung der unoperierten eitrigen Entzündungen der grossen Gelenke. *Arch. f. klin. Chir.* 931 184 95.
- LARSEN, A. Zur operativen Behandlung schwerer Kniegelenkerkrankungen. *Deutsche Ztschr. f. Chir.* 1927 300 576.
- LANDET, A. and BUN, L. A propos du bactériophage. *Bull. et mém. Soc. nat. de chir.*, 1931, 57375.
- LATVAT. Quoted by Duquet.

24. LOWE, PETER. A Discourse on the Whole Art of Chyrurgerie. 3d ed. London, 1634.
25. MACNAMARA, C. Lectures on Diseases of Bones and Joints. 3d ed. London J & A. Churchill, 1887.
26. MIRAILLE, C. Sur un cas d'arthrite gonococcique guéri par injections locales de bacteriophage antistaphylococcique. Bull. et mém. Soc. nat. de Chir., 1931, 57:877.
27. PAYR, E. Verlauf und Behandlung von Gelenkerkrankungen. Leipzig Vogel, 1916.
28. PERMISTER, D. B. Effect of pressure on articular surfaces in pyogenic and tuberculous arthritides and its bearing on treatment. Ann Surg. 1924, 80:481. Changes in articular surfaces in tuberculous and in pyogenic infections of joints. Am. J. Roentgenol. 1924, 12:1.
29. REICH, R. S. Purulent arthritis. J Bone & Joint Surg., 1928, 10:354.
30. TRÉPÉY, P. Sur le bacteriophage. Bull. et mém. Soc. nat. de chir. 1931, 57:655.
31. UELAND, O. Active movements in treatment of purulent arthritis. Norsk Mag. f. Lægevidensk., 1920, 81:358. Quoted by Kortzeborn and Hesse.
32. VAN DE VELDE, J. Treatment of acute septic arthritis by Wilkema's method. J. Lancet, 1920, 40:483.
33. WIART, P. A propos du bacteriophage. Bull. et mém. Soc. nat. de chir., 1931, 57:918.
34. WILLEMS, C. Treatment of purulent arthritis by wide arthrotomy followed by immediate active mobilization. Surg. Gynec. & Obst. 1919, 28:546.
35. WISEMAN, RICHARD. The Severall Chirurgical Treatises. London 1676.

SUBTOTAL VERSUS TOTAL HYSTERECTOMY

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THE recent literature concerning hysterectomy for non-malignant pelvic conditions shows a definite trend of opinion toward the employment of the total rather than the subtotal or supravaginal operation. This tendency seems to be due largely to emphasis on the possibility of subsequent development of cancer in the stump of the cervix uteri, though the more radical operation has also been recommended for the relief of cervicitis alone. As apparent justification for this position a majority of the reports seen by us during the last 5 years show very little or even no greater mortality with total than with subtotal hysterectomy (Table I).

TABLE I—MORTALITY IN TOTAL VERSUS SUBTOTAL HYSTERECTOMY

	Subtotal hysterectomy		Total hysterectomy	
	Number	Mortality per cent	Number	Mortality per cent
Masson	217	8	199	3
Kelton		3	478	9
Fullerton and Faulkner	609	4.4	1,073	4
Burch and Burch	186	4	33	3
May and Mayo	3,085		1,588	8
Greenhill	1,817	4.47	331	4.7
Read and Bill	1,730		603	3
Total	7,795	6	4,559	3

From the figures in Table I we can calculate 7 795 subtotals with 199 deaths or a mortality rate of 2.6 per cent, and 4 559 totals with 139 deaths or a mortality of 3.0 per cent. However a critical review of the reports containing these series makes the figures less convincing. The series reported by Mayo and Mayo refers to the hysterectomies for fibroid only which were done at the Mayo Clinic from 1916 to 1929 and includes some of Masson's cases. They believe that in their figures the difference in favor of the subtotal operation may be apparent only because of sampling or the occurrence of graver risks among those selected for the total removal. They further believe that the latter reason also explains the higher mortality for total hysterectomy in other reports. Von Graff expressed the same opinion.

Such reasoning is so contrary to usual surgical practice that we are at a loss to explain it, unless the reference is to operation in the presence of infection of the cervix or of malignancy. In fact, it is not uncommon when a total hysterectomy seems desirable, to be forced to resort to the less formidable subtotal operation on account of poor condition of the patient before or during operation or because of technical difficulties. Read and Bill conclude that subtotal hysterectomy carries less risk "in spite of the fact that it includes those patients who are poor operative risks." Nelson gives as partial explanation for the higher mortality with the supravaginal operation in his series that "it has often been done in poor risks." Moreover in regard to puerperitis he makes the interesting observation that the danger should be as great in cutting through the infected cervix as through the wall of the vagina which "is more accessible and can be more easily sterilized than the cervix." The exceptionally high mortality for the subtotal operation in the report by Fullerton and Faulkner is unexplained. Similar figures in Greenhill's series were due to the unusually high mortality (8.9 per cent) with subtotal hysterectomy plus bilateral salpingectomy in cases with advanced tubal and ovarian infections involving adhesions to adjoining structures. Where hysterectomy alone was done, the mortality was 5.5 per cent for total and only 0.8 per cent for subtotal. The series of Burch and Burch contains too few totals to be of much significance. With the exception of Fullerton and Faulkner all authors who mention morbidity and complications show them to be more frequent with total hysterectomy. Fullerton and Faulkner give their incidence of shock, injured vessels, hemorrhage, etc. as 5.5 per cent for total and 6 per cent for subtotal hysterectomies, the difference (0.5 per cent) in favor of total being reversed if cardiac complications are not included. It might be said also that some, at least, of these statistics were derived from special clinics and therefore cannot be used as a general guide in private practice.

We have undertaken a study of abdominal hysterectomies done at Harper Hospital with the expectation that the figures from this large general hospital might fairly represent the relative results to be expected from the two types of operation in private practice. Our study included

the 5 years from January, 1928, through December, 1932, during which time there were 1,379 abdominal hysterectomies for benign gynecological conditions. This is exclusive of all cases of cervical carcinoma regardless of type of operation. To make the conditions under which the two operations were performed as nearly comparable as possible, we further excluded operations done in the presence of malignancy of the body of the uterus and of the adnexa. Cesarean sections or ruptured uteri followed by hysterectomy were also not included. It is noteworthy, however, that the inclusion of these eliminated cases (80) would have changed the mortality figures only a fraction of one per cent. Of the 1,376 operations 1141 were subtotal hysterectomies with 30 deaths and 235 total with 15 deaths—a mortality rate of 2.6 and 6.4 per cent, respectively. The combined mortality rate was 3.3 per cent.

TABLE II.—HARPER HOSPITAL SERIES SHOWING MORTALITY

Year		Number	Per cent	Mortality Per cent
1928	Subtotal	841		0
	Total	66	7.7	0.1
1929	Subtotal	238		1.9
	Total	61	26.7	6.5
1930	Subtotal	237		2.2
	Total	24	10.1	8.9
1931	Subtotal	220		2.3
	Total	24	10.9	8.8
1932	Subtotal	202		1.0
	Total	19	9.4	5.2
	Subtotal	1,141		2.6
	Total	33	2.9	6.4

Table II gives the number of both operations with their mortality rates for each year. It also shows the yearly percentages of total hysterectomies. The mortality rates for the subtotal operation have remained at a fairly constant level whereas those for the total have tended to diminish. In addition, it is seen that the years with the lower percentages of total hysterectomy had a somewhat lower mortality rate for that operation. On the assumption that possibly the lower rates were due to a tendency to elect the subtotal operation for poor risks, the years 1929 and 1931 were studied. In 1929, the total operation was done on 11 poor risks (hemoglobin below 70 per cent, cardiac disease, nephritis, diabetes), and in 1931 on 10. The subtotal operation was performed on 32 in poor condition in 1929 and 38 in 1931. Because of the small yearly number of

cases, we consider these figures as merely suggestive.

It has been stated in the literature that the apparent advantages in mortality of subtotal over total hysterectomy varied with the skill and experience of the operator, the inference being that the more experienced operators could obtain as low mortality rates with total as subtotal hysterectomy. To test this assertion we investigated the whole group of 235 total operations, and for comparison the 458 subtotals done in 1929 and 1931. The years 1929 and 1931 were selected as being at neither extreme of time and therefore probably representative, the mortality rate, moreover for these periods being the same as for the whole group of subtotal hysterectomies. We found that the 693 operations (total and subtotal) had been done by 46 different gynecologists and general surgeons of greatly different experience as evidenced by the number of hysterectomies performed by each. Two operators did 50 or more during these periods, five, 25 or more and less than 50, thirty-eight, less than 25. Table III shows the comparative mortality rates for these groups. A separate classification was given the clinic cases as these were in large part operated upon by a series of five residents, though under the supervision and usually with the assistance of a senior attending gynecologist. Besides demonstrating the value of experience, this table shows a lower mortality for subtotal hysterectomy in every division, and except in the clinic cases the difference is striking.

TABLE III.—COMPARATIVE MORTALITY OF DIFFERENT OPERATORS

Cases per operator	Subtotal hysterectomy Mortality per cent	Total hysterectomy Mortality per cent	All cases Mortality per cent
50 plus	0.7	4.5	2.2
25 to 49	0.9	4.3	1.9
1 to 24	4.2	11.9	6.6
Clinic	4.8	5.4	5.1

The immediate causes of death with the actual numbers for both subtotal and total hysterectomy are shown in Table IV. In general these figures confirm those usually given except for the higher incidence of infection and peritonitis in our series. The percentage occurrence of these causes was approximately 57 per cent of the subtotal and 73 per cent of the total hysterectomy deaths, or mortality rates of 1.5 per cent and 4.7 per cent, respectively, from these causes alone. Embolus caused deaths in 0.5 per cent with the subtotal

and 0.8 per cent with the total operation. Shock with myocardial failure resulted fatally in 0.4 per cent and 0.8 per cent of the 141 subtotal and 235 total hysterectomies. These statistics show that the usual causes of death (peritonitis, embolus, and shock) were common to both types of operation but occurred to a greater degree in total hysterectomy.

TABLE IV—IMMEDIATE CAUSES OF DEATH

	Peritonitis and infection	Emboli	Shock and myocardial failure	Dissection	Pneumonia	Total
Deaths in 141 subtotal hysterectomies	7	6	5	5		23
Deaths in 235 total hysterectomies						5

The influence of accessory procedures at the time of operation was studied in the groups mentioned in Table IV, viz. the 235 totals for all 5 years as compared to the 458 subtotal hysterectomies for the years 1929 and 1931. Removal of the uterus without the adnexa resulted in 1 death in 66 totals and 5 deaths in 174 subtotals—a mortality rate of 1.5 per cent and 2.9 per cent, respectively. With salpingectomy or salpingo-oophorectomy the results were quite different, for with the 147 totals there were 13 deaths (8.8 per cent) and with the 247 subtotals there were 7 deaths (2.8 per cent). Of the 147 totals with salpingectomy or salpingo-oophorectomy there were 80 with definite clinical and laboratory evidence of pelvic inflammation such as extensive adhesions or subacute or chronic salpingitis. The mortality was 10 per cent. In 67 cases with no note of pelvic inflammation there was a mortality of 7.4 per cent. Among the 247 subtotal hysterectomies with the same accessory procedures there were 165 showing pelvic inflammation and 82 without, the mortality being 3 and 2.4 per cent, respectively. It is probable that many cases designated by us as without pelvic inflammation were actually complicated by the condition although it was not so stated in the histories. It is quite evident that the higher mortality of hysterectomy plus salpingectomy and salpingo-oophorectomy was due in part, at least, to difficulties encountered because of pelvic inflammation as was noted also by Greenhill. This observation is supported by the mortality rates of subtotal and total hysterectomy for fibroid with and without pelvic inflammation as shown in Table V.

Of other accessory procedures appendectomy was the most frequent, being done in 83 or 35.3

TABLE V—MORTALITY WITH AND WITHOUT PELVIC INFLAMMATION

	Subtotal Mortality per cent	Total Mortality per cent
Hysterectomy for fibroids without pelvic inflammation	6	3.8
Hysterectomy for fibroids with pelvic inflammation	3	10.9
With and without pelvic inflammation	9	7

per cent, of the totals and in 230 or 48 per cent of the subtotals. Three of the patients in whom total hysterectomy plus appendectomy were done died, a mortality rate of 3.6 per cent as compared to 6.4 per cent for the whole group. There were no deaths among the subtotal cases with appendectomy. We believe these results should not necessarily be interpreted as indicating that removal of the appendix added no danger to hysterectomy but rather that appendectomy was reserved in general for the more favorable cases. Supporting the latter possibility and without taking into account technical difficulties etc. is the fact that among the totals with appendectomy there were 8.4 per cent poor or questionable surgical risks (hemoglobin below 70 per cent, cardiac disease, nephritis, diabetes) as compared to 19.1 per cent for those without appendectomy. Among the subtotal hysterectomies plus appendectomy there were 10.9 per cent poor risks as compared to 19 per cent for the remainder of those done in 1929 and 1931. Other accessory operations such as perineorrhaphy, colporrhaphy, cholecystectomy, and herniorrhaphy were performed in an additional 21 of the totals and 35 of the subtotals—with 1 death among the totals.

DISCUSSION

Our investigations indicate a definitely higher mortality for total hysterectomy than for the subtotal operation. Furthermore we believe that statements in the literature to the contrary are not convincing when the data on which they are based are analyzed. On the other hand, it seems that when hysterectomy is to be undertaken and there is also a definite indication for removal of the cervix, the more radical operation is not unduly dangerous in the best operative risks.

The actual incidence of carcinoma developing in the cervix after subtotal hysterectomy is not known but the possibility is worthy of consideration. Polak estimated the occurrence at 2 per cent a figure which would possibly justify the frequent employment of total operation. But, this is far higher than that stated by other

writers. Von Graff quotes Hochmann as giving 0.27 per cent. Mayo and Mayo reported 99 cases seen at the Mayo clinic from January, 1910, to July 1930, only 15 of these, however being in women who had been operated on there. They believe the low incidence in their own cases was due to coming out the cervical canal from above. This procedure may well be of some importance, but it does not remove the usual site of cervicitis and carcinoma of the cervix—the region of the external os. Of much greater value, we think, is their suggestion that following subtotal hysterectomy the cervix be removed later from below or that enucleation of the cervical canal or cauterization be carried out. In several instances where total hysterectomy seemed indicated but was not done on account of the patient's condition one of us has later removed the stump of the cervix without difficulty, but this has the obvious objection of additional hospitalization. In cases in which the cervix is torn and infected but not sufficiently so to make its removal imperative, thorough cauterization or conization under anesthesia before the abdominal incision is made should accomplish much in preventing carcinoma in the cervical stump. Moreover the rare, very early, and therefore local and unrecognized carcinoma would almost certainly be destroyed. In our series the operation records of the 458 subtotals done in 1929 and 1931 showed only 16 of these accessory operations on the cervix though probably some cauterizations were done later because of persistent leucorrhoea.

SUMMARY

Although there is a definite tendency in the recent literature to ascribe to total hysterectomy a mortality comparable with that of the subtotal operation, a critical study of the reports leaves one far from convinced. In our 5 year series there were 1,376 abdominal hysterectomies (ex-

cluding malignancy, caesarean section followed by removal of the uterus, and ruptured uterus) of which 1,141 were subtotal and 235 total with mortality rates of 2.6 per cent and 6.4 per cent, respectively. There was a tendency for the total hysterectomy mortality to be lower in the years with a relatively smaller proportion of the more radical operation. All groups made on the basis of surgical experience of the operator (number of operations per operator) showed an advantage in mortality for subtotal hysterectomy. Pelvic inflammatory disease made hysterectomy more dangerous and explained in part, at least, the higher mortality of hysterectomy with removal of the adnexa. With accessory operations such as appendectomy and perineorrhaphy, the lower mortality was apparently associated with a selection of the better risks for these additional procedures. The danger of carcinoma developing in the stump of the cervix after subtotal hysterectomy is seemingly not sufficiently great to justify the additional risk of the total operation in any but a small proportion of cases. Other less dangerous procedures should be more frequently recommended.

REFERENCES

1. BURCH, L. E., and BURCH, J. C. *Am. J. Obst. & Gynec.* 1931 31 704
2. FULLERTON W. D. and FAULKNER, R. L. *J. Am. M. Ass.* 1930, 95 1563
3. GREENHILL, J. P. *Am. J. Obst. & Gynec.* 1932 24 183
4. HOCHMANN, S. S. Quoted by Von Graff. *Am. J. Obst. & Gynec.* 1926, 11 566.
5. MAYO, J. C. *Am. J. Obst. & Gynec.* 1927 14 486.
6. MAYO C. H. and MAYO C. H. and *Ann. Surg.* 1931 93 1215
7. NELSON H. M. *J. Michigan State Med. Soc.* 1929, 28 860
8. POLAK, J. O. *New York State J. Med.* 1921 21 45
9. READ, C. D. and BILL, A. C. *J. Obst. & Gynec. Brit. Emp.* 1933 40 740
10. VON GRAFF E. *Am. J. Obst. & Gynec.* 1932 23 195

DIVERTICULA OF THE STOMACH

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ANATOMICALLY the term "diverticulum," is applied to a blind tubular process and pathologically to any malformation having this character. Akertund described gastric diverticula as rounded, pocket-shaped or bag-shaped protrusions from the lumen of the stomach. Thus, broadly speaking, the term includes not only true diverticula, whether congenital or acquired but also diverticular formations resulting from intrinsic lesions of the gastric wall, such as ulcer or neoplasm. In this paper only true diverticula will be considered in detail.

Diverticula occur in the stomach less commonly than in other portions of the alimentary tract with the possible exception of the jejunoileal region. Fraser stated that these lesions occur in the different parts of the alimentary tract in the following order of frequency: colon, rectum, duodenum, pharynx and oesophagus, stomach, jejunoileum. The statistics of Larimore and Graham are in accord with this statement. In a series of 3,446 examinations of the digestive tract with the opaque meal they found 105 diverticula: 71 were in the colon, 19 in the duodenum, 9 in the oesophagus, 3 in the stomach, and 3 in the jejunum.

The first case of diverticulum of the stomach was reported by Helmont in 1804. Since that time we have found 108 cases, either mentioned or reported in detail in the literature. As might be expected, most of these have been reported since roentgenological examination has become available in diagnosis. Many of the cases reported have not been confirmed at operation or necropsy. This detracts materially from the reliability of the reports because of the difficulty in distinguishing roentgenologically true gastric diverticula from false diverticular formations. Our series includes 14 proved cases of diverticula of the stomach.

Four of the specimens of diverticula were obtained at necropsy and 10 were removed at operation. Diverticula of the stomach have been diagnosed roentgenologically in 25 cases at the Mayo Clinic since 1926. In 6 cases of the group exploratory operations revealed only 2 to be true diverticula; in the 4 others, diverticular pro-

trusions were found to be due to perforating peptic ulcer or to carcinoma. The 19 remaining cases, in which diagnosis was made roentgenologically but not proved or disproved at operation or necropsy, are not included because of the frequent confusion in the roentgenologic diagnosis of these lesions.

CLASSIFICATION

Diverticula of the digestive tract have been variously classified as congenital, or true, acquired or false, and pulsion or traction types. True (congenital) diverticula have been considered to have intact muscular and mucosal layers, whereas false (acquired) diverticula have been considered to be those diverticular formations in which one or more of the mural layers are absent. The terms "pulsion" and "traction" are self-explanatory and have been used frequently in connection with true and false diverticula. Kaushch pointed out that the terms "congenital" and true and "acquired" and "false" are not always synonymous. Brandes substantiated this statement by reporting a case of an acquired diverticulum in which all layers of the wall of the sac were present.

It is thus evident that there is much confusion and some inaccuracy in the classification of these abnormalities. In order to simplify the subject of gastric diverticula we suggest the following subdivisions:

1. *True diverticula*. Those in which the pouch includes all coats of the gastric wall without definite evidence that organic disease was the causative factor. Such diverticula probably are congenital (Fig. 1).

2. *Acquired true diverticula*. In these all coats of the gastric wall are present although there may be some thinning, and there is evidence that some disease was instrumental in causing the pouching.

(a) *Pulsion type diverticula* result from intra-gastric pressure which is probably localized.

(b) *Traction type diverticula* are incidental to extragastric adhesions (Fig. 2).

3. *False diverticula or diverticular formations*. In these there is a break in the gastric wall resulting from disease (Fig. 3).

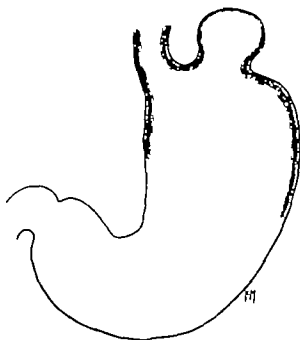


Fig. 1 True diverticulum at the cardiac part of the stomach. The mural elements are intact but are thinned out.

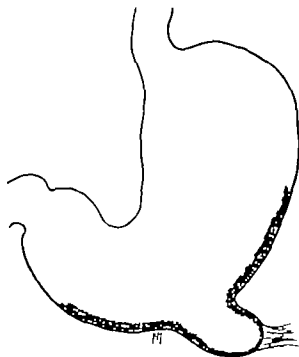


Fig. 2. Acquired true diverticulum of traction type. All layers of the wall of the sac are present, and there is some thinning at the site of the adhesive band.

HYPOTHESES AS TO FORMATION

True diverticula. The etiology of true diverticula is unknown. The question even has been raised as to whether a truly congenital type exists at all. Zahn went so far as to state that no diverticula reported up to 1899 were congenital. Laurell and others expressed the belief that these true diverticula are of the pulsion type and are caused by intra-abdominal pressure among persons with a lax abdominal wall. That this is the true explanation is doubtful since true diverticula have occurred in young muscular adults and in children. Gile reported a case of a girl aged 7 with a diverticulum, and Sinclair one of a 4 months old infant, both being confirmed at operation.

Furthermore as has been demonstrated by Gianturco and others intragastric pressure is ordinarily quite low. At the cardia where most diverticula occur, the pressure is lowest ranging from 5 to 2 centimeters of water. Alvarez has distended the fresh stomachs of cats and dogs under pressures much greater than those occurring physiologically without producing diverticula. The objection may be raised that this experiment was inadequate, and that continued or repeated pressure would be necessary for the development of diverticula. On the other hand, Fraser consistently produced multiple diverticula in the jejunum by briefly distending this part of the bowel; he thus confirmed his belief that jejunal lesions could be acquired.

Despite views to the contrary, it seems to us that the weight of evidence favors a congenital basis for this group of gastric diverticula. Diverticula are not uncommon in lower animals especially in the pig. The tip of the fundus in this animal normally develops as a diverticulum. The sloth of South America has a cardiac diverticulum normally (Alvarez). However the fact that this animal virtually lives in an inverted posture might be interpreted by exponents of the idea as adding weight to the hypothesis that diverticula are acquired by pulsion. The beaver has a projection of the pylorus at the greater curvature of the stomach. The fish *Lophius piscatorius* or angler has protrusions from the pylorus at each curvature and the American aquatic herbivorous mammal the manatee, has three diverticular compartments namely, at the pars media on the greater and lesser curvatures and at the cardia (Huntington). All ruminants, as well as certain forms of aquatic life such as the *Argyroneta aquatica*, *Asterias rubens* and others, have similar gastric compartments (Buetschli).

In attempting to explain the occurrence of diverticula of the stomach in man embryologically, Kalbfleisch stated that the fundus of the stomach of man develops as a pouch on the outer side of the cardia. He expressed the belief that, in congenital diverticula another smaller pouch develops and remains connected with the stomach by a narrow neck. This hypothesis would

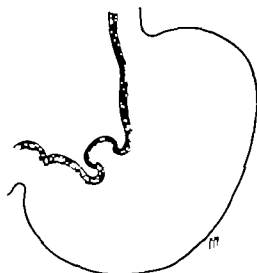


Fig. 3. False diverticulum due to weakening of the gastric wall by ulcer.

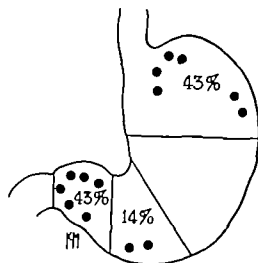


Fig. 4. The situation of the diverticula in our series of cases.

explain only those diverticula that occur at the cardia. It is interesting to note that diverticula of the pyloric region have not infrequently been found in association with aberrant pancreatic tissue. Nauwerck, Falconer, Weischelbaum, Kolb, Wagner, and Gegenbauer found pancreatic tissue in such diverticula. Gille demonstrated heteroplasic colonic mucosa in a gastric diverticulum, and pancreatic tissue adjacent to it.

Anatomically, there is thinning of the circular and oblique muscular fibers at the cardia. Large vessels that enter the gastric wall in this region also contribute to the muscular weakness and make it a site of lowered resistance. Thorel and Zalin believed that this part of the stomach was subject to the greatest strain as food passed along the *Magenstrasse*.

In view of the fact that diverticula of the type under consideration have been found in all regions of the stomach, and almost uniformly present muscular and mucosal elements, which are thin, it seems possible that these diverticula may occur as a result of a congenital localized weakness of the gastric wall. The natural anatomical weakness at the cardia and the frequent presence of pancreatic tissue at the pylorus, could account for the relative frequency of diverticula at these sites. On the other hand, the thinness of the wall of the sac may be secondary to pressure of gastric contents accumulating in the diverticulum. Such a hypothesis would fit in with the conception that diverticula, as such, exist as vestigial phenomena. It would at least seem reasonable to assume that congenital, anomalous conditions precede develop-

ment of such an abnormality if it does not already exist at birth.

Acquired true diverticula. The etiology of this type of diverticulum is usually obvious. Adhesions to the gall bladder, pancreas, and spleen are probably the more common factors producing traction. Jones reported a case in which the gastric wall was adherent to the gastroduodenal ligament and colon. Kalbfleisch expressed the belief that this case was probably one of ulcer. Chutro described a case of diverticulum with adhesions to the abdominal wall at the site of a hernia. Von Hansemann reported another case with adhesions to an epigastric tumor. A pulsion diverticulum was caused by a trichobezoar in a case reported by Schulten.

Acquired false diverticula. The gastric wall may be weakened by inflammatory reaction, ulceration, or by neoplasm. It is conceivable that intra-gastric pressure or progressive ulcerating processes could produce pouching at the site involved.

REVIEW OF MATERIAL IN THIS SERIES

Incidence. Ten specimens in our group were removed in 10 of 11,234 consecutive exploratory operations on the stomach, or 1 in 1,235. Four specimens were obtained in the course of 3,663 routine postmortem examinations, or 1 in 917. Twenty-five roentgenologic diagnoses of gastric diverticulum were made in the course of 91,532 routine roentgenologic examinations of the stomach at the clinic since 1926. As has already been mentioned, many of these were probably not true diverticula.

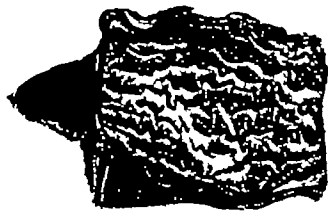


Fig. 5 True cardiac diverticulum specimen obtained at necropsy

Age The ages of the patients in this series ranged from 25 to 59 years 9 were 40 years of age or older and 5 were from 25 to 40 years of age. The average age was 42 years.

Sex Diverticula occurred about equally often in either sex 6 of the patients were men and 8 women.

Situation The situation of diverticula in cases reported in the literature varies but they seem to occur most often in the cardia, just below the esophageal juncture on the posterior wall and usually nearer the lesser than the greater curvature. According to reports they occur next most often at the pylorus, near one or the other curvatures. In our series of proved cases 6 diverticula were found immediately adjacent to the pylorus, 6 at the cardia, and 2, some distance from the pylorus on the posterior wall (Fig. 4).

Pathologic findings Diverticula of the stomach in proved cases reported heretofore have varied in diameter from 1 to 5 centimeters. In our group the smallest diverticulum was 1 centimeter in diameter and the largest, 7.5 centimeters (3 inches). The neck of the sac is usually narrow and may or may not be thickened. Grossly, the mucosal and serosal surfaces appear intact. Microscopic examination of sections of the wall of the sac reveal the presence of the mucosal and muscular layers but these are thinned out. Pancreatic tissue was not found in the diverticulum in any



Fig. 7 Section of wall of true diverticulum. All layers are intact but are thinned out. $\times 65/5$

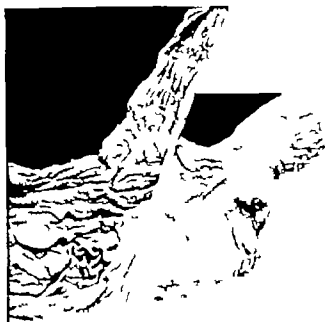


Fig. 6 True diverticulum at the cardiac end of the stomach. Specimen obtained at necropsy with esophagus intact.

of our cases (Figs. 5, 6, 7, 8). Acquired, or so called false diverticula, may have a deficiency of the mucosal layer or of one or more muscular layers, or both, and the serosa often gives evidence of adhesions to adjacent viscera.

Associated gastric disease Associated gastric disease was found in 4 of our 14 cases (30 per cent). In 2 cases, there were ulcers adjacent to the diverticula (in 1 case at the cardia, and in the other at the pylorus), in 1, an adenomyoma in the diverticulum and a duodenal ulcer and in the remaining case a sarcoma in the wall of the diverticulum. What part, if any the adenomyoma and the sarcoma played in the development of the



Fig. 8. Wall of normal stomach adjacent to diverticulum. $\times 65/5$

diverticulum is problematic. Cleve, Puskepelles, and Nauck considered that such lesions developed in pre-existing diverticula, whereas Bell and Golden doubted whether these should be classed as true diverticula. The literature contains reports of a number of cases with associated disease similar to those in our group. Cleve reported a myoma in a diverticulum, Sandstrom a diverticulum with a benign adenoma, and C. H. Mayo, von Hanseemann, Miller and Mellon and others cancerous or precancerous changes in diverticula.

Two or more diverticula in the gastro-intestinal tract. Of the 14 cases included in this report in 2 demonstrable diverticula were present elsewhere in the digestive tract. In 1 case, multiple diverticula in the colon were found and in another a duodenal diverticulum was found.

SYMPTOMS

The general opinion of writers on the subject is that most diverticula of the stomach cause no definite symptoms and are usually not of clinical importance. However some cases have been reported in which there was epigastric distress, positive roentgenologic evidence, and apparent relief following surgical treatment.

In 1 case of our group the patient complained of hæmatemesis, and blood clots were found in the diverticulum. Definite evidence of blood dyscrasia developed later. In 4 cases part or all of the symptoms may have been attributable to the diverticulum; in 4 the complaint was accounted for by associated gastric or duodenal ulcers, and in 1 a sarcoma may have been responsible for some of the symptoms. Thus in 10 of the 14 cases (71 per cent) symptoms could not be attributed to the diverticulum *per se*. In the 4 cases (excluding the one with hæmorrhage) in which the symptoms may have been related to the diverticula epigastric pain was present which might or might not be relieved or aggravated by food, in 2 vomiting had occurred on several occasions (in 1 case probably due to cardiospasm) and in 3 epigastric tenderness was present.

DIAGNOSIS

The recognition of a true gastric diverticulum without the aid of the roentgenogram is impossible, as there is no characteristic clinical syndrome (Fig. 9). Even the roentgenologic findings are difficult to interpret, as is evident from the fact that in 4 of 6 of our cases in which the diagnosis had been diverticula these diverticula were found at exploration to be false sacs due to malignant disease or to perforating ulcer. The 2 cases in which true diverticula were found were the only

cases in our group of proved cases in which the pre-operative diagnosis was correct. Both of these diverticula were at the cardia. However one is probably justified in making a diagnosis of diverticulum when the roentgenologic findings are consistent and the patient has epigastric distress which is not attributable to other disease.

A number of writers stress the difficulty of roentgenologic diagnosis. Sandstrom said that the diagnosis depends on a niche like opaque spot surrounded by a defect in the contrast shadow, the appearance of which is also typical of ulceration with surrounding infiltration. Pendergrass outlined the differential diagnosis of diverticulum and hernia through the oesophageal hiatus. He stated that hernias are best seen with the patient in the recumbent Trendelenburg position and that they are larger during inspiration and smaller during expiration because of variations in intra-abdominal pressure. A gastric diverticulum on the other hand, does not reveal these changes.

COMPLICATIONS

A complication occurred in but one (7.1 per cent) of our proved cases, in this instance being hæmorrhage. This case has previously been reported by Sutherland. Hæmorrhage also has been reported by Brown, Akerlund, Gale, and by Sinclair.

TREATMENT

The treatment in 10 cases of our series was surgical. The diverticula were removed by local excision, by sleeve resection of the stomach, or by pylorotomy. When gastric or duodenal lesions were associated with diverticula, the surgical procedures were modified according to the type of disease that obtained. The indication for treatment of a diverticulum in the upper portion of the stomach rests on a positive roentgenologic diagnosis plus the presence of epigastric distress not referable to other disease.

Bell and Golden felt that postural drainage should be tried in cases of diverticula at the cardia, as carcinoma has never been reported in this group. They believed that surgery should be performed in all cases in which the lower two thirds of the stomach was involved, because of the possibility of associated malignant disease and the frequently mistaken roentgenologic diagnosis of diverticula in this region. In the light of the present study we are led to concur in this opinion. The consensus of opinion favors excision of the sac as the procedure of choice, although inversion of the diverticulum, gastro-enterostomy and gastric resection have been performed in some instances.

REPORTS OF CASES

SURGICAL

CASE 1. A man, 36 years of age, came to the clinic because of stomach trouble of 3 to 4 years' duration. He complained of a "hot spot" in the upper portion of his abdomen that had been more or less constantly present but had never been aggravated by heavy foods. He made the statement that it felt as though a sac were present near the entrance of the stomach, because there was a dull pain in this region similar to that caused by food packed in the socket of a tooth. Epigastric tenderness was present.

Analysis of gastric contents revealed a total acidity of 60, free hydrochloric acid of 40, and a total quantity of 140 cubic centimeters. The roentgenologic diagnosis was diverticulum of the cardiac end of the stomach. Other findings were irrelevant.

Exploration revealed a diverticulum at the cardia immediately below the esophagus, passing to the left and along the fundus of the stomach. The diverticulum was excised. The pathologist reported that the diverticulum was 3 by 4 centimeters in diameter with thinned out muscular and mucosal layers.

One year later the patient reported that he was well.

CASE 2. A woman, 38 years of age, complained of abdominal distress of 12 years' duration. The symptoms had been somewhat indefinite. She stated that the region of maximal distress was situated to the left of and above the umbilicus, although pains elsewhere in the abdomen were not infrequent. Belching and alkalis were said to have given relief, whereas food had had no effect on her symptoms unless at times to aggravate them. She occasionally had awakened at night with epigastric pain that usually had radiated to the sternum. She presented the multiple, bizarre complaints so often encountered in neurotic persons.

General physical examination gave negative results. Analysis of gastric contents revealed a total acidity of 44, free hydrochloric acid of 32, and a total quantity of 100 cubic centimeters. The roentgenologic diagnosis was diverticulum on the posterior wall of the cardia.

At operation, a diverticulum was found on the posterior wall of the stomach at the cardia and also an ulcer next to the pylorus. The lesions were excised. The pathologist reported that the diverticulum was 2.5 centimeters in diameter with an opening into the stomach 1 centimeter wide.

CASE 3. A man, 43 years of age, complained of a dull, aching pain in the upper portion of his abdomen, of which he had been aware for 1 year. The pain had been constant and had been somewhat intensified after meals. Some epigastric tenderness had also been present.

Analysis of gastric contents revealed a total acidity of 70, free hydrochloric acid of 50, and a total quantity of 175 cubic centimeters. The roentgenologic diagnosis was prepyloric ulcer.

At exploration a diverticulum, 4 centimeters in diameter was found on the greater curvature and removed by resection of the pyloric third of the stomach. A posterior Polya anastomosis was made. The pathological diagnosis was diverticulum.

CASE 4. A woman, aged 30 years, entered the clinic because of stomach trouble during the previous 4 years. She complained of pain in the epigastrium following a heavy meal, which had been relieved by emesis and massage of the abdomen and partially alleviated by taking soda. Slight epigastric tenderness was present.

Analysis of gastric contents revealed a total acidity of 40, free hydrochloric acid of 32 and a total quantity of 35 cubic centimeters. The roentgenologic diagnosis was duodenal ulcer with moderate retention.



Fig. 9. Diverticulum of cardia. Fluid level is evident.

A diverticulum producing obstruction, a centimeter from the pyloric ring on the gastric side, was discovered. Pylorotomy was performed. The diagnosis of diverticulum was confirmed pathologically.

CASE 5. A woman, 26 years of age, came to the clinic because of dysphagia and spasmodic substernal pain that had been present for 10 months. She also had had pain in the epigastrium from 1 to 2 hours after meals. There had been some regurgitation at times. Dilatation of the esophagus had relieved the substernal pain, but had failed to affect the distress in the epigastrium.

Exploration revealed a diverticulum, 3 inches (7.5 centimeters) deep at the lower margin of the stomach near the pylorus. The lesion was excised and the pathologist's report confirmed the diagnosis.

Eighteen years later the patient complained of symptoms referable only to cardiospasm.

CASE 6. A man, 51 years of age, entered the clinic because of weakness, anemia, and tarry stools during the previous 9 months. Examination of the blood revealed that the concentration of hemoglobin was 43 per cent, that erythrocytes numbered 3,120,000 and leucocytes 8,100 per cubic millimeter and that the color index was 0.7 per cent. There was a total gastric acidity of 90, free hydrochloric acid of 72 and a gastric content of 80 cubic centimeters. The roentgenologic findings were suggestive of a benign lesion at the pyloric end of the stomach.

On exploration, two diverticula containing clotted blood were found on the posterior wall of the stomach near the greater curvature and about 3 inches (7.5 centimeters) from the pylorus. The lesions were excised by sleeve resection of stomach. Pathologist's report confirmed diagnosis.

Definite signs of a blood dyscrasia developed later.

CASE 7. A man, 50 years of age, complained of vague, gastric intestinal disturbance not characteristic of any definite disease. Roentgenologic diagnosis was carcinoma of the stomach. A tumor on the posterior wall, 3 inches (7.6 centimeters) away from the pylorus was removed. The pathologist reported that the lesion was a diverticulum, 3 centimeters long with a fibromatous starting in the submucosa. The patient died subsequently from extension of the malignancy.

CASE 8. A man, 40 years of age, was operated on because of gastro-intestinal symptoms indicative of peptic ulcer. A diverticulum was found contiguous to a perforating ulcer at the pylorus. Excision and a Finney type of pyloroplasty were performed. The surgical findings were confirmed pathologically. Six years later gastro-enterostomy was performed for recurrence of symptoms.

CASE 9. A woman, 40 years of age, was operated on because of symptoms ascribed to peptic ulcer. A duodenal ulcer was found. Adenomyoma in a diverticulum with an opening 2 centimeters in diameter also was present. The diverticulum was on the lower border of the stomach, just proximal to the pylorus. Excision of the diverticulum and gastro-enterostomy were performed. The pathologist's report was confirmatory. Three months later the patient wrote that she was cured.

CASE 10. A woman, 50 years of age, was operated on because of symptoms indicative of peptic ulcer. A duodenal ulcer and a diverticulum, 1 centimeter in diameter in the pyloric region, were excised. A Billroth I anastomosis was performed. The surgical diagnosis was confirmed pathologically. One year later the patient complained of stomach trouble.

POSTMORTEM

CASE 1. A woman, 55 years of age, died following surgical drainage of an appendiceal abscess. Necropsy revealed among other lesions a large diverticulum of the cardia and diverticula of the colon.

CASE 2. A man, aged 40 years, died of cardiac aneurysmal disease. Necropsy revealed among other lesions a diverticulum, 1 by 3 centimeters which was situated 4 centimeters from the cardia.

CASE 3. A woman, 44 years of age, died following hysterectomy for carcinoma of the uterus. Necropsy revealed among other lesions a diverticulum, 1 by 3 centimeters in diameter situated 8 centimeters below the esophagus. A duodenal diverticulum also was found.

CASE 14. A woman, 55 years of age, died of carcinoma of the esophagus. Necropsy revealed a diverticulum of the cardia partially covered by epithelium of the esophageal type.

SUMMARY AND CONCLUSIONS

An effort has been made to review in some detail a relatively large group of diverticula of the stomach seen at the Mayo Clinic.

Diverticula in the stomach are rare and, to our knowledge, only 141 cases have been mentioned or reported in detail to date, including our 33 cases, 19 of which were not proved.

In 10 (74 per cent) of the 14 proved cases which we report, there were no symptoms referable to diverticulum in 4 symptoms which may have been related to diverticulum were present.

The cause of true diverticula of the stomach is not definitely known. The hypothesis that they

are congenital is plausible. The cause of the acquired types usually is obvious.

The situation of gastric diverticula in cases reported in the literature was most often at the cardia and next most often at the pylorus, although they have occurred in every portion of the stomach. In our series the diverticula were equally distributed at the cardiac and pyloric regions of the stomach.

Associated peptic disease was present in 4 of our 14 cases (30 per cent) and consisted of gastric ulcer, duodenal ulcer, adenomyoma, and sarcoma. Similar associated lesions have been reported in cases in the literature.

The diagnosis is difficult. In our series 4 of 6 pouches diagnosed roentgenologically as diverticula proved to be pouches which developed as a result of perforating ulcers or malignant lesions.

Complication occurred in only 1 of our cases and in that instance, consisted of hemorrhage. Such hemorrhages have been reported by other writers.

In view of the fact that it is extremely difficult to ascertain with accuracy the nature of a diverticulum of the stomach, it would seem to us that with roentgenologic evidence of such a condition and the presence of indigestion, it would be safer to advise surgical exploration.

BIBLIOGRAPHY

1. ASHBAKE, WALTER C. Personal communication to authors.
2. ANDERSON, A. L. Diverticula of the stomach from the roentgenologic point of view. *Acta Radiol* 1923, 2: 476-485.
3. BELL, J. C. and GOLDIE, ROSE. Diverticula of the stomach, report of four cases. *J. Am. M. Ass.*, 1930, 94: 334-339.
4. BRADLEY. Quoted by Fraser.
5. BROWN, G. E. An unusual stomach case with roentgenographic findings. *J. Am. M. Ass.* 1916, 66: 1918-1919.
6. BUTSCHKE, OTTO. Vorlesungen ueber vergleichende Anatomie der Ernährungs Organe. Berlin: Julius Springer, 1924, 344 pp.
7. CARMAN, R. D. and MILLER, ALBERT. The Roentgen Diagnosis of Diseases of the Alimentary Canal. 3d ed. Philadelphia: W. B. Saunders Company 1923, 558 pp.
8. CATTRO. Quoted by Kallthiesch.
9. CLIVE, A. Diverticuli und Divertikel Myome des Magens. *Arch. f. path. Anat. u. Physiol.* 1925, 255: 375-383.
10. FALCONER, A. W. A case of congenital diverticulum of the stomach and duodenum in a physiological hour-glass stomach (removal). *Lancet*, 1907, 1: 906.
11. FRANK, LAM. The diverticula of the Jejunum-Ileum. *Brit. J. Surg.* 1933, 21: 183-211.
12. GROENHAUSER. Quoted by Bell and Goldie.

13. GIANTURCO, CERRA. Personal communication to authors.
14. GILL, J. F. Diverticula of the stomach. *New England M. J.*, 1931 304:268-269.
15. HAMMERMANN F. VOM. Magendivertikel. *Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte*, 1895 p 514.
16. HELLMONT. Quoted by Bell and Golden.
17. HUNTERTON G. S. *The Anatomy of the Human Peritoneum and Abdominal Cavity Considered From the Standpoint of Development and Comparative Anatomy* Philadelphia Lea Bros. and Company 1903, 202 pp.
18. JONES. Quoted by Kalbfleisch.
19. KALEFLEISCH, W. K. Diverticula of the stomach. *Am. J. Roentgenol.*, 1928, 20:218-223.
20. KAUSCH. Quoted by Fraser.
21. KOLB. Quoted by Bell and Golden.
22. LARIMORE AND GRAHAM. Quoted by Fraser.
23. LAURELL, HOO. Zur Frage der Entstehung Kardianaher Magendivertikel und senkretischer Oesophagusdivertikel. *Zugleich im Beitrag zum Schluckmechanismus. Acta. Radiol.*, 1931 12 435-478.
24. MAYO C. H. Diverticula of the gastro-intestinal tract. *J. Am. M. Ass.*, 1919 59:260-264.
25. MELLOW R. R., SOBLE, N. W., DAVIDSON, S. C., and FOWLER, W. F. The incidence of carcinoma in gastro-intestinal diverticulosis. *Surg., Gynec. & Obst.* 1921 33 177-182.
26. NAUCK. Quoted by Bell and Golden.
27. NAUWERCK, C. Zur Kenntniss der Divertikel des Magens. *Deutsch. med. Wchnschr.* 1920, 1 119.
28. PENNERGRASE, E. P. Diverticulum of the upper end of the stomach. *Surg. Clin. N. America* (Dec.) 1931 2 1493-1496.
29. PURCEPILLIER. Quoted by Bell and Golden.
30. SCHULTEN M. W. Ueber Haargeschwoelste im Magen nebst Mittheilung eines gluetzlich operierten Falles. *Mitt. u. d. Grenzgeb. d. Med. u. Chir.* 1897, 2 289.
31. SINCLAIR, NEIL. Congenital diverticulum of the stomach in an infant. *Brit. J. Surg.*, 1929, 17 182-184.
32. SUTHERLAND C. G. Diverticula of the stomach with hemorrhage. *Radiology*, 1925 5 523-524.
33. THORPE. Quoted by Kalbfleisch.
34. WAHNER. Quoted by Bell and Golden.
35. WEINCHILBAUM. Quoted by Bell and Golden.
36. ZAHN GEORG. Ein Beitrag zur pathologischen Anatomie der Magendivertikel. *Deutsch. Arch. f. klin. Med.*, 1899, 63:359-367.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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JANUARY 1935

IDIOPATHIC DILATATION OF THE SYSTEM OF EVACUATION

SURGEONS who perform operations on the sympathetic nerves to the viscera in the pelvis are becoming familiar with coexistent dilatation of the sigmoid colon and possibly rectum, the urinary bladder and the ureters. As a rule the primary object of the operator has been to relieve the symptoms of Hirschsprung's disease by sympathectomy and the dilatation of the lower urinary tract has not been suspected. Although there is still doubt as to the exact nature of the lesion that leads to the pathological changes in the colon characteristic of Hirschsprung's disease, the present consensus is that a congenital defect in the neuromuscular mechanism of the distal part of the colon is present. The proportion of cases of idiopathic dilatation of the colon that is associated with dilatation of the lower urinary tract is still unknown but it is high enough to direct attention to the probability and it is likely that the routine investigation by intravenous urography of patients suffering from Hirschsprung's disease will

show the association to be common. In such cases the obstruction to the outflow of urine from the ureters and the bladder appears to result from achalasia at the ureterovesical junctures and at the internal sphincter of the bladder respectively.

It is probably of significance that the dilated structures receive their sympathetic innervation from the same source—the superior hypogastric plexus or presacral nerve—and this view is supported by the degree of success that has attended efforts to overcome these neuromuscular obstructions by resection of the nerve. A single anatomical lesion cannot be responsible for all the cases that fall into this broad group for indubitably the dilatation may be confined to the colon to the ureters and bladder to the bladder alone or to one ureter. The pathology of the condition is even more obscure.

Of more practical moment to the surgeon is the early recognition and if possible correction of this state of affairs. The lesions involve the structures that are concerned in the final ridding of the body of its waste products—the system of evacuation—and inefficiency of this system must sooner or later prove fatal. Sympathectomy for Hirschsprung's disease appears to be a well tried and satisfactory operation. One of the most important factors in determining its effect on the urinary tract appears to be the state of the walls of the ureters, for long continued stasis and infection of urine may lead to changes of a chronic inflammatory nature which destroy their contractility. But the whole matter is far from surgical finality.

J. R. LEARMONTH

THE SURGICAL TREATMENT OF HYPERTENSION

ONE of the latest developments in the field of surgery of the sympathetic nervous system is the treatment of hypertension. Secondary forms of hypertension, such as those associated with nephritis and arteriosclerosis, as well as the paroxysmal form associated with suprarenal tumors, are not included in the group to be considered for this type of surgery.

The type of hypertension that has responded to operations on the sympathetic nervous system is the primary or constitutional form which occurs among comparatively young people. It is progressive in spite of medical treatment, and carries a prognosis comparable to that of malignant neoplasms. This severe type of essential hypertension may be designated as the malignant type. Because no definite etiological factors have been found, it has been assumed that a constitutional neurogenic abnormality plays an important part in the disease. Following this assumption, and because vasospastic diseases which are due to neurogenic imbalance have been relieved by sympathetic ganglionectomy, operations on the sympathetic nervous system have been carried out in an attempt to relieve hypertension.

There is close parallelism between the disturbed vasospastic mechanism of Raynaud's disease and that of primary hypertension. In both conditions hyperactivity of the vasomotor center in the brain is believed to be at fault. Since surgical interruption of the vasomotor fibers to the extremities relieves the symptoms of Raynaud's disease, it is rational to believe that interruption of the vasomotor nerves to a large portion of the vascular tree would have a depressor effect.

Among the first operations for relief of hypertension were sympathetic denervations of the upper and lower extremities. This did

not affect a sufficient portion of the arterioles to modify the systemic blood pressure, and so, desiring to denervate not only the vessels of the lower extremities but also those of the abdominal cavity, the spinal roots from which sympathetic fibers proceed to the latter region were divided. In order to accomplish this, it seemed necessary to perform laminectomy and rhizotomy of the anterior and posterior roots from the sixth thoracic to the second lumbar segments, inclusive.

Following this operative procedure there was noted a definite and significant drop in blood pressure. In addition to interruption of the vasomotor fibers, there was paralysis of the abdominal muscles, which reduced the intra abdominal pressure. While the desired effects on the blood pressure were achieved, the procedure was considered too radical as a routine form of treatment and a less hazardous procedure was sought. In view of the fact that the splanchnic nerves carrying the sympathetic fibers from the anterior roots to the abdominal viscera could be approached by a less extensive operation they were resected as they entered the abdominal cavity between the crura of the diaphragm. Following this type of operation, a definite drop in blood pressure occurred and definite relief of symptoms was noted in milder and earlier cases, although results did not seem so satisfactory in the more advanced cases. For that reason the previously described rhizotomy was modified to the extent that only the anterior roots were divided. This procedure proved effective in bringing about a significant lowering of blood pressure.

A further modification of this type of operative procedure consisted of the division of the ninth thoracic to the second lumbar roots inclusive, in an effort thereby to produce a maximal drop in blood pressure with a minimal amount of risk.

Several important observations have been made following the two types of rhizotomy. There have been no noticeable deleterious effects, except possibly slowing of the excretion of water which has not resulted in serious complication. Absence of sweating over the abdomen and lower extremities testifies to the division of the vasomotor fibers. There is a postural drop in blood pressure in that the pressure is higher when the patient is prone and lower when the patient is erect. Lessened response in blood pressure to psychic, thermal and pain stimuli has been noticed and marked change in the mean levels of both diastolic and systolic pressures has been maintained over a sufficient time to indicate definite therapeutic value.

It may seem radical to advise resection of the splanchnic nerves or extensive laminectomy and rhizotomy for patients who have this type of hypertension but who have very few symptoms, yet, in the light of experience it would seem that if operation is to be done at all it should be done before

changes in cerebral retinal, and renal arteries are too advanced.

In spite of the fact that cases are on record in which patients have been followed for two years after splanchnic resection and four years after rhizotomy and beneficial effects have persisted for these periods of time this type of treatment of hypertension should be considered as investigative and more or less experimental until a larger series of patients have been treated and more time has elapsed for postoperative observation. If surgery of the sympathetic nervous system should prove of as permanent value in the control of progressive primary constitutional hypertension as it has in the treatment of some of the vascular diseases affecting the extremities and of other conditions in which hyperactivity of the sympathetic nervous system has been of etiological importance, then it will have achieved another victory in the treatment of a disease which has been found to be resistant to all other forms of therapy.

WITCHELL MCK. CRAIG



HARRY M. SHERMAN
1854-1921

MASTER SURGEONS OF AMERICA

HARRY MITCHELL SHERMAN

HARRY MITCHELL SHERMAN the first specialist in orthopedic surgery on the Pacific Coast was born in Providence, Rhode Island, November 23, 1854. His paternal ancestor came from England in 1633. On his mother's side, the family were descendants of an old French Huguenot family, Mauran by name.

His preliminary education was in St. Paul's School, Concord New Hampshire, and in 1877 he was graduated as Bachelor of Arts from Trinity College, Connecticut. His medical degree was from the College of Physicians and Surgeons, New York, in 1880, which college later became the Medical Department of Columbia University. In that same year, Trinity College granted him the degree of Master of Arts. His hospital internship was in Bellevue, New York, and he served for a time as assistant surgeon at West Point Foundry, New York. In 1881, he became assistant to Dr. Murdock at Cold Spring-on-the-Hudson, and later had some experience as ship surgeon on one of the steamships of the Alexandre Line.

In February, 1885, he came to San Francisco and entered practice, soon becoming associated with the late Dr. George Chismore, the eminent urologist.

Since he had had special training in orthopedic surgery with Dr. Lewis A. Sayre in Bellevue, he recognized in San Francisco an opportunity to develop that specialty, which until then had been in the hands of general surgeons.

In 1886, he became orthopedic surgeon to the Children's Hospital, San Francisco, organized in 1875 by a group of women headed by Dr. Charlotte Blake Brown, and he soon made that institution the center of orthopedic surgery on the Pacific Coast.

In 1890, he married Matilda Barreda, daughter of Frederick Barreda, Peruvian minister to the United States. Mrs. Sherman died in 1895, leaving one son, Frederick Barreda Sherman. In 1896, Dr. Sherman spent a year in Vienna, studying orthopedics.

In 1900, Dr. Sherman married Lucia Hamilton Kittle, daughter of J. G. Kittle, of Ross, California. Of this marriage there were two daughters, Lucia Kittle and Isabel, who, with the son, Frederick Barreda, and Mrs. Sherman, survive.

Dr Sherman suffered from asthma for a number of years, but notwithstanding this handicap he had an unusually full professional life with great accomplishment. Finally his heart broke down after an attack of influenza, and he died May 15 1921

Dr Sherman was made clinical professor of orthopedic surgery in the University of California in 1896 and professor of the principles and practice of surgery in 1899, which position he held until 1912. In 1901 he was appointed surgeon to St. Luke's Hospital, San Francisco, where he did much operative work. He recognized that in cleft palate work he could see in the depth much better if he had dark instead of white draping. He therefore experimented with colors in the operating room and finally hit upon dark green tiling and dark blue draperies and gowns as most restful to the eye, favoring illumination of the depth of surgical wounds. Like other of Dr. Sherman's original notions, the green color has been chosen for the tiling of operating rooms in numerous other institutions.

He was an active member in many surgical organizations—The American Orthopedic Association, 1899 (president in 1900), The American Surgical Association, 1905. In 1912 he was one of the organizers of the San Francisco Polyclinic and later did yeoman work in organizing the American College of Surgeons in California, of which organization he was one of the governors. It is of some interest to note that after the San Francisco earthquake and fire of 1906 Dr. Sherman was the inspiration for the opening of a teaching hospital for the University of California Medical Department—he started with one bed and one patient, he himself furnishing the equipment—an institution which has become one of the most prominent teaching hospitals in the country.

While Dr. Sherman's chief work was in orthopedics, he did not limit his efforts to that specialty, but did much creditable work in other fields—cleft palate surgery, of the spleen, surgery of tumors, and even brain surgery. He did much experimental work on suture of heart wounds. He operated a number of times for the removal of the gaseric ganglion for facial neuralgia, and it is fair to assume that the broader view of pathological problems thus acquired reacted to the betterment of his orthopedic surgery.

Endowed with tireless energy, he gave much time and thought to matters of public welfare. In his relations with his fellow man, he was always the gentleman in the best sense of the word.

In the late war, having been for some years an officer in the Medical Reserve Corps of the United States Army, he was called to active duty with rank of major and served as surgeon in command of the Army Hospital at Fort Rosecrans, San Diego, until the end of the War. As a teacher, and in his clinical work, he was painstaking to an extreme, and his private and hospital records are models of concise systematic work, largely in his own hand.

Of Dr Sherman's contributions, perhaps the following are most noteworthy

Open operation for congenital dislocation of the hip, in which he overcame the usual rotation of the femur by an infratrochanteric osteotomy, holding the fragments in proper position by means of drills or spikes incorporated in the plaster-of paris dressing. A more fundamental idea was the use of sterile salt solution as a filling for cavities in bones and other places, Sherman making the point that the fluid was eventually replaced by blood into which bone gradually grew and the irritation from foreign bodies such as the various pastes which had been previously used, was avoided.

He invented an extremely useful instrument, a spreader for opening plaster of paris splints.

In 1902 he presented a notable paper before the American Surgical Association on the surgery of the heart.

Dr Sherman's position as surgeon is not to be measured by his contributions to literature, for they were not numerous though of telling quality, but by his influence on those who came into contact with him, for they could not fail to catch some of his enthusiasm. He was a careful and thorough clinician, an excellent operator, a splendid teacher who had the faculty of attracting young men to his work and it is noteworthy that the present generation of orthopedic surgeons in San Francisco were nearly all Sherman's students.

ELMET RIXFORD

EARLY AMERICAN MEDICAL SCHOOLS

THE HISTORY OF RUSH MEDICAL COLLEGE

GOLDER LEWIS McWHORTER, M.D. Ph.D., CHICAGO

RUSH MEDICAL COLLEGE was granted a charter on March 2, 1837 antedating that of the city of Chicago by several days. It was the only medical school in Chicago until 1859 and the only one of five pioneer medical schools in that vicinity to continue without interruption to the present time.

Largely to Daniel Brainard (Fig 1) must be given the credit for its establishment and early development. Arriving in Chicago in 1836 only two years after his graduation from Jefferson Medical College he soon demonstrated unusual foresight, ambition, and executive ability. Chicago, at this time was a rapidly growing village of three thousand. In the adjacent community were many practitioners who had received either no medical education or had failed to graduate, while only about 20 per cent of them were medical graduates. Due to the poor transportation, the demand for physicians was great and the expense together with the inaccessibility of the few eastern medical schools placed the study of medicine largely beyond the reach of possible students from the local community.

Resulting from the local need at this time, there developed five pioneer medical schools in the vicinity of Chicago.

The medical department of LaPorte University was founded in 1842. It became the medical department of Indiana Medical College in 1848 and was discontinued in 1850.

Franklin Medical College was organized at St. Charles, Illinois, in 1842 and discontinued in 1849.

The medical department of Illinois College at Jacksonville was established in 1843 and discontinued in 1848.

Rock Island Medical School was organized in 1848 moved to Davenport, then to Keokuk, and later became a part of the University of Iowa.

Rush Medical College was named after Dr. Benjamin Rush (1745-1813) of Philadelphia. He was one of the foremost medical men and citizens of his time, a graduate of Princeton in 1760. Edinburgh in 1768, professor of medicine in the University of Pennsylvania, a signer of the Declara-

tion of Independence, and treasurer of the United States mint from 1799 to 1813.

In his publications in 1854 Daniel Brainard did not appear to favor the name Rush. He termed himself professor of surgery of the Medical College of Illinois at Chicago and later called it the Medical College of Chicago without mentioning the name Rush. Perhaps the lack of more than grateful appreciation by the relatives of Rush, to the commemoration of his name at a time when the College was in serious financial straits was the reason.

Although a charter was obtained in 1837 with the expectation of an early opening of the school, economic conditions were very bad and it would probably not have opened in 1843 but for the organizing of the schools at LaPorte and St. Charles. This forced Daniel Brainard to open Rush sooner than he wished.

As a result an announcement was issued in October 1843 stating that the first session would begin December 4, 1843 and continue for 16 weeks, before obtaining a college building. The lectures were given in the second story of a frame building occupied by Dr. Brainard as his office and next door to his home, at 49 South Clark Street, at the south east corner of the alley south of Lake Street. The requirements for the degree of doctor of medicine were, "Three years study with a respectable physician, two courses of lectures, one of which must be in this institution (or two years practice will be received in lieu of one course). The candidate must be 21 years old of good moral character must present a thesis on some medical subject of his own composition, and in his own handwriting which shall be approved by the faculty, and pass a satisfactory examination on all the branches taught in this College.

The first course was given to a class of 23 students with one graduate. The instruction was given by four men with an average of four lectures a day. From the first, clinical teaching was established in the dispensary. This was opened by Dr. Blakey in 1839 as the first free dispensary in Chicago. Upon the opening of the College

in this block in 1843, it was transferred to the College quarters. In 1845 this dispensary was moved to Wolcott and Kinzie Streets and called the City Dispensary. Later it was adopted as a county institution.

During the summer of 1844 a building for the College was erected north of the river at Indiana and Dearborn Streets at a cost of about \$3500.00 (Fig. 2). This served without a change for eleven years. The land was donated by interested real estate men while the faculty and a few others furnished the money.

Austin Flint, as professor of medicine, gave the introductory address in the new building the first annual anniversary of Rush. He remained only one year, due, partly to an inadequate income from the ticket fees by the students.

Medical instruction at first given by a few of the leading physicians in the larger communities was now rapidly taken over by these pioneer medical schools. With the phenomenal growth of Chicago and the strong faculty at Rush it soon became the dominant medical school. There was also considerable feeling against them in the smaller communities because of the necessity for grave robbing and many gruesome tales are told of these early teachers of anatomy and their students who had to obtain their own specimens for dissection. The robbing of a grave at St. Charles caused local indignation to run high with the death of one student and the closing of that medical school in 1849. It was not until 1885 that the State of Illinois legalized the disposition of unclaimed bodies to medical institutions for use in teaching.

By 1850 three of the other five pioneer medical schools had discontinued and a fourth had moved west of the Mississippi River. Five hundred and thirty-two students had studied and 132 had graduated from Rush which had now become strongly established.

While these pioneer medical schools were often referred to as "proprietary" this was not literally the fact, although the property rights did rest with boards of trustees which included medical men.

Among the original seventeen trustees of Rush, only one was a physician and he was not on the faculty. However, shares of stock in Rush Medical College were issued and sold largely to the faculty members who from time to time, were called upon to finance the institution. Dividends were also paid upon this stock.

In the summer of 1850 Chicago had a population of over 25,000. The United States Marine Hospital located only a short distance from the



Fig. 1 Daniel Brainard, 1818-1866

College was nearing completion. Professor Herick of the College assumed charge and clinics were held there in 1853-54.

The Illinois General Hospital of the Lakes, or the "Lake House" was organized with a living in department. It came under the management of the Sisters of Mercy and after the first year was called Mercy Hospital. In 1851-52 Professors Brainard and Davis were in charge of the surgical and medical services and held clinics there. In the College announcement of that year there appeared, but not without some objection, the notice that the requirements of graduation would include hospital attendance.

In 1855 the College building was enlarged to accommodate about 250 students at a cost of \$15,000.00 sustained by the faculty. A museum was included with space for many specimens which had been collected by Professor Brainard in Europe.

In 1856 the College announcement contained a defence of hospital ward teaching as practiced the preceding four years in the Mercy and Marine Hospitals.

Early in 1859 N. S. Davis and a group of the faculty who favored a graded course of instruction resigned and founded what was for a time known as the Medical Department of Lind University, afterward as the Chicago Medical College, and later the Medical Department of Northwestern University, Mercy Hospital being used for their clinical teaching.

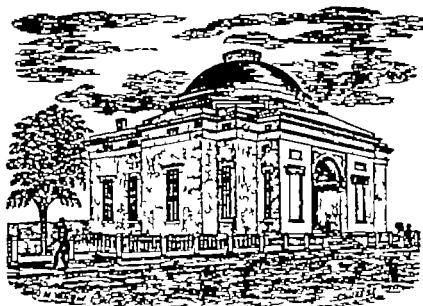


Fig. 2 Rush Medical College building erected in 1844.

Rush Medical College then announced that in addition to the Marine Hospital they would use the newly opened 200 bed City Hospital for teaching. Following the Civil War the City Hospital was taken over as the Cook County Hospital in 1866.

A course of lectures was inaugurated in the spring and early summer in 1850 by the Rush faculty. In 1860 the College announcement called it the Chicago Summer School of Medicine. This was later called the spring and summer lecture course of Rush Medical College and continued almost without interruption until the regular course was extended to 8 months in 1893. In 1860 the College announced a preliminary course of lectures of 2 weeks in addition to the regular course of 16 weeks.

Daniel Brainard died of Asiatic cholera October 10, 1866 aged 54 years, during an epidemic in Chicago then a city of 200,000. Despite this the College continued without interruption.

In May 1867 the corner stone of an additional building containing an amphitheater with 625 numbered seats was laid and the old structure remodeled at a cost of about \$70,000.00 which was financed by the faculty.

In the spring of 1867 Moses Gunn was invited to the chair of surgery and for 20 years until his death rendered a great service to the institution. In 1867 the requirement of a formal thesis was abandoned and the regular course was increased from 16 to 18 weeks. In 1871 it was increased to 20 weeks.

On October 9, 1871 during the great fire the buildings of the College were burned. There was almost a complete loss from the fire and Rush was left \$65,000 in debt largely to the faculty.

Teaching was continued in a clinical amphitheater of the Cook County Hospital and in the dissecting rooms of the Chicago Medical College generously offered to them. The rebuilding was delayed until the permanent location of the new County Hospital could be determined so that the College building could be erected adjacent to it.

During this period a temporary crude brick structure for lecture and dissecting rooms, costing about \$4,000.00 was built on the grounds of the old County Hospital at 18th and Arnold Streets. The College occupied this for 4 years from 1872 to 1876. The corner stone of the building at the present location, the corner of Harrison and Wood Streets, chosen because it was diagonally opposite the new Cook County Hospital was laid November 20 1875. The formal opening took place on October 4, 1876 (Fig 3). The lot and building cost about \$54,000.00. Most of the money was obtained from the faculty and \$11,000.00 from the Central Free Dispensary which occupied the first floor.

From the first use of the Blaney Dispensary Rush has always maintained the importance of clinical teaching. When the first building was erected clinics were held there for the medical and surgical treatment of patients before the students. This dispensary was abandoned with the burning of the building in 1871. The County Hospital

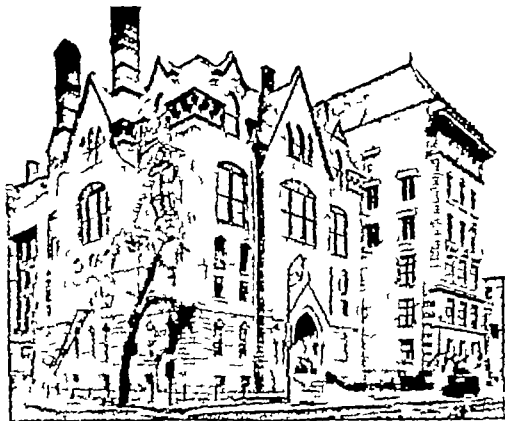


Fig. 3 The corner building of Rush Medical College which was used from 1876 to 1914, when it was replaced by the Rawson Building. Senn Hall in the background is still in use.

clinics were used until the opening of the new building in 1876.

The Central Free Dispensary was organized May 4, 1867, under the title of the Brainard Free Dispensary and was supported at first by private donations, occupying small rooms at 239 W Randolph Street. In 1873 it was united with the Herick Free Dispensary, founded in 1871. The endowment at that time was brought up to \$11,000.00 which in 1875 was lent to Rush for a first mortgage on the lot. The College agreed to provide rooms for the dispensary and to furnish medical service with the privilege of using the patients as teaching material for the students.

While these quarters were changed in June 1902 to Senn Hall and later back to the Rawson Building the clinical teaching in the dispensary has never been interrupted. The dispensary and the affiliation with the Presbyterian and Cook County Hospitals may be called the three principal assets of Rush Medical College. The Presbyterian Hospital was organized and building started in 1883 through the efforts of the faculty and an agreement made so that it could be used for teaching purposes. The staff of the hospital almost without exception has always been composed of members of the faculty of the College.

In 1882 for the first time a preliminary examination required in English, physics, and mathematics was held for those matriculating in Rush unless they were graduates of accredited high schools or their equivalent. This was necessary to qualify for practice in Illinois (1884). At this time instruction in the College began to assume a graded character.

In 1877 the regular course was increased from 20 to 21 weeks.

In 1879 the College urged, but did not require for graduation attendance at the spring and summer terms, in addition to the regular term of at least 2, if not 3 years, with a minimum of 3 years of study as heretofore. The period of study was divided into six terms over 3 years.

In 1887 the College required, in addition to studying medicine at least 3 years, that the minimum of two required courses of lectures for the degree of medicine must not have been delivered in "one twelve-month."

After the death of Moses Gunn in 1887, Charles T. Parkes was given the chair of surgery and Arthur Dean Bevan, a graduate of Rush (1883) was elected to the chair of anatomy. In 1888 Nicholas Senn was given the chair of principles of surgery and surgical pathology.

In 1889 the College announced that beginning in 1891 three full courses of lectures, at least 6 months each, would be demanded for graduation.

In 1891 at the death of Charles T. Parkes, Nicholas Senn was given the chair of surgery.

In 1892 the announcement stated that each matriculate, in accordance with the state law, must study medicine 4 years and take three courses of lectures of at least 5 months each. The College requirements for graduation were increased to 4 years of study and an attendance at three courses of lectures of 6 months each.

In 1893 the regular course was made to cover 8 months and the spring course was discontinued.

A new laboratory building was dedicated on December 4, 1893, just 50 years after the beginning of the first course of lectures.

In 1894 it was announced that after 1895 four full courses of lectures would be required of 8 months each in graded courses. This requirement was changed to go into effect June 1, 1897. At this time (1897) the College still held preliminary examinations for students who were not graduates of high schools or their equivalent.

The early affiliations of Rush Medical College are only of historical interest, as they created no change in the methods of teaching, or indeed affected the College in any noticeable manner.

In the annual announcement for 1862-63 Rush Medical College was recognized as the medical department of the University of Saint Mary's of the Lake, located at the corner of State and Huron Streets. No further notice was ever made.

On May 1, 1875, plans were made for Rush to become a department of the old University of Chicago. Although so described in the announcement of 1874-75 the union was never consummated and the subject was never mentioned again in the meetings of the trustees of the College.

In June, 1887, Rush Medical College became the Medical Department of Lake Forest University, but it did not involve any close relations and each retained its own autonomy. This relation was dissolved by mutual consent in April, 1898, and almost immediately the affiliation of the College with the University of Chicago was established. The affiliation of Rush Medical College in June, 1898, marked an epoch in medical education not only in the College but in the history of medicine in America.

By the terms of this affiliation, the College surrendered control of its property to the University, which at this time made it clear that it was not its intention for Rush to necessarily become its medical school. The University stated that it proposed to establish its own medical school when funds

became available. Rush adopted as far as possible the general regulations of the University. One of the most satisfactory has been the continuous session, or four quarter arrangement, of the college year. This was established for the session of 1899-1900, when the first 2 years of the medical course was transferred to the University.

The increased requirements led to a falling off of the number of students, the lowest being in 1905-06 when the freshman class numbered about 65. This was a marked contrast to the classes of 200 to 250 which was the rule in the preceding years. Few changes were made in the clinical faculty except to increase it somewhat in numbers.

Since 1914 the requirements have included a fifth year consisting of a hospital internship or of a fellowship in one of the departments.

With the death of Nicholas Senn in 1908, Professor Arthur Dean Bevan succeeded him as head of the department of surgery. In 1934 Dr. Vernon C. David was given the chair of surgery at the retirement of Professor Bevan who had served his Alma Mater as a teacher for 46 years.

In May 1924 a new contract was executed between the Corporation of Rush Medical College and the University of Chicago, in accordance with which the affiliation of 1898 was superseded and the University took over the work of the College as a department. This went into effect June 16, 1924. Thereafter only the last two years of clinical work has been offered by Rush Medical College.

With the organization of the School of Medicine of the Division of the Biological Sciences of the University of Chicago, the work of the first 2 years of medicine, formerly given in co-operation with Rush, was increased to include the third and fourth clinical years, in the university hospitals and clinics. It was so arranged that the work of the third and fourth years could be taken either on the quadrangles or in Rush Medical College. In 1924 the old college building, used since 1876, was replaced by the Rawson Clinical Laboratory and the Norman Bridge Laboratory of Pathology.

Before the affiliation of Rush with the University there were 525 graduates. To September, 1934, there has been a total of 9,917 graduated from Rush Medical College.

Rush Medical College, through the efforts of its faculty by means of its opportune and successful affiliations with clinics, hospitals, and the University of Chicago, and through the discoveries and services of the physicians who have studied there, has achieved immortality. May Rush so continue, as in the past, to signify the best in medicine.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE fourth edition of Blair Bell's most excellent textbook of gynecology¹ has been expanded and enlarged in its scope. Chapters have been added on the history of gynecology on ethics, and on the medicolegal aspects of gynecology. It is gratifying to find a chapter on contraception even though the discussion of this subject leaves much to be desired. The author might well have made this chapter more complete, since reliable information on this subject has not yet found its way into the standard text books.

The chapters on the problems in endocrinology on endometrioma, and on malignancy have been rewritten and brought up to date. Many new illustrations have been added throughout the book. The admirable style in which the previous editions have been written, has been carried over into this edition. This work should continue to be one of the standard English textbooks of gynecology.

RALPH A. REED.

THE fascinating story² by Frederick Watson of the life of Sir Robert Jones, once begun, is difficult to lay down until one has read to the end.

The story tells itself so simply and directly that the reader hardly realizes until he has completed it that this book is beautifully written and a very great credit to the writer's art.

If one could sum up the story of Sir Robert Jones' life in a few words they would be that he was a man loved far above the measure which usually falls to the lot of men. Throughout his life and work that devoted affection of family, associates, friends, patients, and even casual acquaintances, stood out predominantly and furnished the most potent factor in the influence he wielded and the results he was able to achieve in behalf of the causes which moved him so strongly.

Fortunate in his parental background and early home life, he was equally fortunate in the opportunity that came to him at the age of 16 to enter the home of his aunt Elizabeth and her husband, Hugh Owen Thomas. In Watson's words

To live under the same roof with Thomas must have been a daily adventure. His passion for work and his asceticism of life did not remove him from his wife and her young nephew. There

were always the evenings or part of them. At the end of a long day's toil he would work on his bath, or play the flute, or discuss in his uncompromising fashion some aspect of life or literature. His range of knowledge upon the most academic subjects was remarkable, and his attitude toward all topics strongly coloured by rationalism.

During these years of Jones' apprenticeship Thomas had an immense practice, and Jones literally grew into the practice of orthopedic surgery and under unusually fortunate conditions.

Between 1890 and 1900, Nelson Street (where Thomas lived) was responsible for the medical supervision of the shipwrights, ironworkers, boiler-makers and dockgate men of Merseyside. The accidents from such employments were continuous and severe. There were still the days of sailing ships, as well as steam, and the old case-books show a steady procession year in and year out of ships' captains, carpenters and seamen of all grades and nations, who had suffered injury at sea or in port. These cases came straight to Nelson Street and were treated there from start to finish, to the advantage alike of patient and surgeon for whereas the former received what was practically specialist attention, the surgeon's gain was the observation of injuries of every kind and at every stage. Thomas never held a hospital appointment. But he was not a loser by that, for although he remained to the end of his life outside the professional camp, he alone was able to treat his cases from start to finish in his surgery and nursing homes.

and

It was to relieve the terrible distress of these people (by the alms) that Thomas opened his free Sunday clinic, where, assisted by a large staff, he laboured from early morning throughout the day. It was at those Sundays that the spectacle of deformed babies and young children first set the mind of Robert Jones upon the problem of crippling diseases.

In 1891 Thomas died, and shortly after Jones moved again from 22, Great George Square, where he had established himself in 1885, to 11, Nelson Street. From that date until 1914 the story is one of almost uninterrupted and joyful work at 11, Nelson Street, at the Royal Southern Hospital, and at Beachchurch, the open air hospital for crippled children founded by Miss Agnes Hunt.

A distinguished American surgeon has written of this period

Mr. Jones begins his day after an early breakfast at 7.30 by visiting his patients at their homes or in his private hospitals where they have been placed. About 11 o'clock he returns to his office, where he passes quickly from one patient to another in the various rooms, spending but a moment with each, but seeing at once with an almost intuitive instinct upon the nature of the affection and the essential indication for treatment. Small operations, such as tenotomies and mobilization of adherent joints, are often done on the spot, his lively optimism and cheerful tact being in many cases the only anesthetic employed. A dozen cases are started, none are finished, patients crowd the rooms and wait in corridors, everything to the outsider is hopeless confusion. But one thread after another is picked up by the busy master, one difficulty after another solved on the spot, order is brought out of chaos, and in an incredibly short space of time each patient had had the proper diagnosis and the proper treatment applied.

¹THE PRINCIPLES OF GYNECOLOGY: A TEXT BOOK FOR STUDENTS AND PRACTITIONERS. By William Blair-Bell, B.S., M.D. (Lond.) F.R.C.S. (Eng.) F.C.O.G. (Hon.) F.A.C.S. (Hon.), LL.D. (Oxon). 4th ed. rev. with the assistance of M. M. Dettow, M.D. B.A. (Lond.) F.R.C.S. (Edn.) M.C.O.G. and Arthur C. H. Bell, M.D. B.S. (Lond.) F.R.C.S. (Eng.), M.C.O.G. Baltimore: William Wood & Co., 1934.

²THE LIFE OF SIR ROBERT JONES. By Frederick Watson. Baltimore: William Wood & Co. 1934.

and has been instructed about house management and when to call again.

The writer has never seen anything approaching this mastery of the clinical material or of the technical science. This was equally displayed in the work at the Royal Southern Hospital, where Mr. Jones has surgical service. On his regular operating day, Wednesday, he often exceeds twenty operations. On the Wednesday of which the writer was present he did twenty-two beginning at 10 p.m. he finished 1 p.m. doing every operation himself but one, which was done by the house surgeon. The operations were done on table which was also used as stretcher, and by having to use these stretcher-tables and its assistants, the operations follow of each other with almost clocklike punctuality. At an average interval of fifteen minutes, and without any appearance of haste. When one considers that these included dressing in most cases and that there are three knee resections, and other operations of equal importance, the performance seems little short of marvellous. All the operations but one were undertaken for the relief of deformity or joint disease.

Here as in the office practice, the striking thing was the clear and quick appreciation of the gist of the matter in hand and the instant application of the simple and effective remedy. Another striking feature of the work was the hearty and intelligent co-operation of his associates. Mr. Jones has attracted to himself a group of young men of skill and experience, who view it with cheer in their devotion to him and to the work, and whose team play if I may use the expression is remarkably effective. There is no question by precedence, the right man is always on hand to do the right thing in the right way. The spirit of the place is as fine as the work and personality of the master.

With the trying days of 1914 came Sir Robert Jones great opportunity but opportunity freighted with grief and great responsibility. How well he acquitted himself and how ably he discharged that responsibility cannot be told in a few words. Most American surgeons are familiar with the story and both the older surgeons and those who 20 years ago were too young to appreciate its significance will delight in reading it in Watson's book. It has added still greater lustre to that of the profession in which we are proud to be enrolled. It has been beautifully summarized by an anonymous writer in the *Journal of Bone and Joint Surgery* (vol. 15 page 542).

Behind his genial, smiling countenance, and apparent simplicity, Robert Jones possessed the keenest brain, the most brilliant organizing ability and the tact, the patience, the perseverance and the selflessness of a diplomat. Never was man faced with greater difficulty or with more serious opposition than he was in the early days of the War when he was entrusted with the establishment of the first military orthopaedic service of this or any other country. He was appointed to the office as Director of Orthopaedics with the rank of Hon. Major General. England's home service began with 200 beds at Alder Hey in Liverpool but within short time the help of many English and American Surgeons was enlisted and 55,000 beds were equipped and staffed with trained orthopaedic surgeons. The brain which had already solved the problems of the cripple in civil life readily adapted itself to the problems of war. Incredible as it may be, the gigantic task was accomplished and complete service established from first and treatment to the field to the last stages of re-education and after-care. In 1918 he continued and completed his military orthopaedic work through his appointment as Hon. Consultant to the Ministry of Pensions. In recognition of his war services, His Majesty conferred upon him the C.B. and later Knighthood, and the United States Army awarded him the Distinguished Service Medal.

After the weary years of war were ended and its tragic aftermath had to some extent been cleared away Sir Robert Jones might well have retired to a life of ease and contemplation of years well spent. He had made "the main principles of Hugh Owen Thomas acceptable to the medical profession," and had

established the specialty of orthopaedic surgery on a firm foundation. Instead of giving up however he plunged into the work that always seemed to crowd upon him more vigorously than ever. The cause of the cripple which had always been so close to his heart, claimed a large share of his attention. To the organization of a national scheme for caring for the physically handicapped and for the prevention of tuberculosis and of rickets—those diseases which contributed so many new recruits to the army of cripples—he devoted that same energy and organizing ability which had accomplished so much for the wounded soldier. The map of England and Wales, dotted with strategically located orthopaedic hospital schools and orthopaedic clinics, tells better than words how successful his efforts were.

While continuing on a larger scale than ever the surgical practice which he had been forced to give up during the war he still found time to edit the *Orthopaedic Surgery of Injuries* which appeared in 1921 and to write in collaboration with Robert Lovett the *Textbook of Orthopaedic Surgery* (1923) which "records for mankind" the principles and teachings which he constantly exemplified in his surgical work.

It seems incredible that in spite of advancing years he could still continue work and play at the strenuous pace that he set for himself but

retirement, leisurely old age, an opportunity to take things easy—all these would have been terrible to him. With ebbing strength, he surveyed the past and set no store on the future. If he could not be in the heart of the battle of life, he shrunk from place in the shadow.

In December 1932 after a year of gradually declining strength he began to fail rather rapidly and on January 14, 1933 he "fell quietly asleep."

To have lived a life so fruitful so filled with service to his fellow men, and to have gone to his last resting place loved and mourned by family by associates, by students, by patients—in short by all who knew him—falls only to the lot of a fortunate few. Watson might well have added to his book the beautiful tribute which appeared in the *Journal of Bone and Joint Surgery* (vol. 15 pages 541-543) which begins and closes with the paragraphs

The kindly word, the cheery smile, the twinkling eye, the whole magnetic personality of Sir Robert Jones remain only as memory. The world's greatest orthopaedic surgeon has completed his life's work, quietly as he was born seventy-four years ago at Ryall on the North Wales coast, just as quietly he died in the early days of this year at little village in Montgomeryshire.

and

Throughout his career he practised in Liverpool, and Liverpool has paid its best and greatest tribute to the loser of one of its citizens. The ashes of Sir Robert Jones are the first to find resting place within the walls of the Cathedral. The urn stands on a column of stone, close to the foundation pillar beneath the stained glass window dedicated to "Service." As long as the walls of that vast cathedral stand, they will shelter all that has died of Robert Jones, as token and memorial of his service to mankind. In the hearts and minds of those who came within the glow of his presence and who learned humbly to love him, his spirit still lives.

SCHOTT L. KOCHE.

VOLUMES vii and ix of the twelve volume *Cyclopedia of Medicine* edited by George M. Pienol and Edward L. Bortz are now available (Review of first seven volumes appeared in the December, 1933 issue page 822.) Volume vii continues the alphabetical arrangement of the subjects beginning with the letter 'L' and the first topic is 'Larynx, Disorders of'. This section covers 69 pages and includes infections and nervous disorders together with the tumors of the organs. The section on metabolism is given 151 pages and covers proteins, fats, carbohydrates, and minerals. Myrrh is the last subject appearing in this volume and its pharmacology, preparations, dosage, and therapeutics are discussed briefly. Volume ix begins with the nails and a discussion of their structure, deformities, care, and disorders. A section of 70 pages is given to plastic surgery where technique is described and illustrated quite freely. The subject of pneumonia is well done. A discussion of potassium and its preparation and doses ends this volume. Attention is called to these topics only in that they indicate the general nature of the subject matter treated.

The volumes are 7 by 10 inches and the binding has been changed from the flexible to the conventional stiff type. The material is well arranged and the treatment of the subjects are concise and remarkably complete. M. HERBERT BARKER.

THE purpose of Dr. Vaughn's monograph of 248 pages is to review the present position of the knowledge of the anemias. She has been assisted by Professor H. M. Turnbull in the description of the pathological anatomy of various anemias. In the first chapter a review of normal erythrocyte measurements and a brief account of the anatomy and physiology of erythropoiesis are presented. The anemias are classified under the general headings of dyshaemopoietic, post haemorrhagic, haemolytic, and unclassified anemias. The anemias of infants and children are included in the classification and in the clinical descriptions. Each individual type of anemia is considered from the standpoint of etiology, symptomatology, diagnosis, and treatment. Abundant reference to the literature is made throughout the text.

Under the grouping of the deficiency dyshaemopoietic anemias, the recent conceptions and literature concerning iron deficiency anemia and anemia due to deficiency of the pernicious anemia factor are presented. The relationship of this group to abnormalities of the gastro-intestinal tract is brought out. Under unexplained dyshaemopoietic anemias, the author includes the less common leuco-erythroblastic anemias. This type of anemia was observed in diseases involving the bones which included

carcinomatosis, myelomatosis, osteosclerosis, and Cooley's anemia. It is suggested that these conditions do not cause anemia by crowding out erythropoietic tissue but rather by depriving the blood cells of food factors necessary for normal ripening. Further under dyshaemopoietic anemia, a description is given of erythroblastosis fetalis which includes hydrops fetalis, icterous gravis neonatorum and congenital anemia of the newborn.

Dr. Vaughn has drawn frequently from her own experience in giving specific details of the findings in various anemias. Characteristic diameters of the erythrocytes are illustrated in the accompanying Price Jones curves. The material in general is presented on the basis of the evidence at hand and there is little if any tendency toward dogmatism. It is of interest that more than half of the articles from the large bibliography appeared after 1929. If hematologic research continues to progress as it has in the past, it is likely that this book will need revision in the near future.

This excellent monograph should be invaluable to the physician or student who wishes to familiarize himself with the revolutionary advances in the knowledge of the anemias that have occurred in the past ten years. It should also serve as a valuable reference book to workers in the field of hematology.

HOWARD L. AUST

IT is a pleasure to see Wright's *Applied Physiology* of which the first edition is dated 1926 already appearing in its fifth edition. Its remarkable popularity among medical students is due to a number of virtues too often lacking in the medical literature of the past. One of these is utmost conciseness of expression. It would be hard to find in these 604 pages, a single superfluous word. Another is utmost conciseness of expression for every generalization there is a specific instance, stated quantitatively when possible. These features adapt the book exactly to its purpose which is to give an up-to-date summary of those facts of human physiology which have clinical application. It is not a book for a beginner since introductory historical and laboratory technical material is excluded. It is a book for the mature medical student who finds the clinical viewpoint stimulating in his study of physiology. It should also be helpful and interesting to physicians and surgeons who find that even conscientious reading of their journals sometimes fails to give a coherent idea of the present state of the science. Among the subjects which many readers will be particularly glad to have presented in this way and to which special attention has been given in the new edition, are blood groups, nephrosis, edema, the anemias, tissue oxidation, the carotid sinus, ischemic pain, sympathectomy, cholecystokinin, the prolans, parathormone, and the hypothalamus.

FREDERIC T. JUNG.

¹THE CYCLOPEDIA OF MEDICINE. George Morton Pienol, B.S. M.D. Editor-in-Chief and Edward L. Bortz, A.B. M.D. Assistant Editor. Vols. vii and ix. Philadelphia: F. A. Davis Co. 1934.

²THE ANEMIAS. By Janet M. Vaughn, D.M. (Oxon.) M.R.C.P. (Lond.) London: Oxford University Press, 1934.

APPLIED PHYSIOLOGY. By Samuel Wright, M.D. F.R.C.P. 5th ed. New York and London: Oxford University Press, 1934.

CORRESPONDENCE

CONCERNING A REGISTRY OF BRAIN TUMORS

To the Editor A series of some two thousand tumors of the central nervous system collected by Dr Harvey Cushing during his period of service at the Johns Hopkins Hospital and the Peter Bent Brigham Hospital has been brought to the Yale School of Medicine and put under the curatorship of the undersigned. It is intended that these elaborately catalogued specimens should so far as possible be made useful to those interested in the subject, and it is hoped that the collection will be added to from many sources.

There are many problems relating to tumor classification and expectancy of life after tumor removal that are as yet unsolved. Hence this series of cases may be of help to those who will encounter rare

tumors that they wish to have identified if possible, and concerning which they may desire information, particularly on the basis of type prognosis.

Anyone who may feel inclined to send specimens for diagnosis or may seek information of other sorts is welcome to do so. The following persons, several of them already familiar with much of the material, have kindly consented to act as an advisory board.

PERCIVAL BAILEY, University of Chicago
F. C. GRANT, University of Pennsylvania
S. C. HARVEY, Yale University
C. J. HENKE, Cornell University
WILDER PENFIELD, McGill University
EUGENE SACHS, Washington University
W. P. VAN WAGENING, University of Rochester
S. B. WOLBAST, Harvard University

LOUIS EISENHART, M.D., New Haven Hospital

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE TREATMENT OF INJURIES OF THE HEAD AND SPINE. By Jewett V. Reed, M.D. Indianapolis: C. E. Parley & Co., Inc., 1934.

THE WELLCOME RESEARCH INSTITUTION AND THE AFFILIATED RESEARCH LABORATORIES AND MUSEUMS. Founded by Sir Henry Wellcome, LL.D., D.Sc., F.R.S., London, England. The Wellcome Foundation Ltd., 1934.

INTRODUCTION TO DISCUSSION ON GEOGRAPHICAL DISTRIBUTION OF CANCER IN SPAIN. THE CANCER OF 1933. By Frederick L. Hoffman, LL.D., Madrid, Spain, S. A., 1933.

TUBERCULOSIS OF THE LYMPHATIC SYSTEM. By Richard H. Miller, M.D., F.A.C.S., New York. The Macmillan Co., 1934.

COLLAUDA DI MONOGRAFIE CHIRURGICHE. Directed by Prof. Raffaele Paolucci. VINCENZI E PIGNATELLI. DIGESTIVE ANDOROMALI CHIRURGICHE. By Francesco Zagari. With a preface by Prof. Raffaele Paolucci. Bologna: Nicola Zanichelli Editore, 1934.

AN INTRODUCTION TO GYNECOLOGY. By C. Jeff Miller, M.D., ed. St. Louis: The C. V. Mosby Co., 1934.

SYMPOSIUM OF GENITOURINARY DISEASES. By Austin I. Dodson, M.D., F.A.C.S., St. Louis: The C. V. Mosby Co., 1934.

APPLIED ANATOMY; THE CONSTRUCTION OF THE HUMAN BODY CONSIDERED IN RELATION TO ITS FUNCTIONS, DISEASES AND INJURIES. By Gwilym G. Davis, M.D., 6th ed., completely revised by George P. Miller, M.D. Philadelphia, London, Montreal: J. B. Lippincott Co., 1934.

ANNUAL CLINICAL REPORT OF THE GOVERNMENT HOSPITAL FOR WOMEN AND CHILDREN, EDMORE, MADRAS, FOR THE YEAR 1933. Madras Government Press, 1934.

WIESE DER VERBUNDUNG DER EVIDENZ UND AUSENDRUNG DER KLINIK. By Prof. Dr. Bernh. Fischer-Wasche. Berlin: Julius Springer, 1934.

PRACTICAL OBSTETRICS FOR STUDENTS AND PRACTITIONERS. By P. Brooks Bland, M.D., and Thaddeus L. Montgomery, M.D., ed. ed. Philadelphia: F. A. Davis Co., 1934.

HEALTHY BABIES ARE HAPPY BABIES. A COMPLETE HANDBOOK FOR MODERN MOTHERS. By Josephine Henshaw Kenyon, M.D. Boston: Little, Brown, Co., 1934.

CATARACT ITS ETIOLOGY AND TREATMENT. By Clyde A. Chapp, M.D., F.A.C.S. Philadelphia: Lea & Febiger, 1934.

TUMORS OF THE FEMALE PELVIC ORGANS. By Joe Vincent Meigs, A.B., M.D., F.A.C.S. With a Foreword by Robert B. Greenough, M.D. New York: The Macmillan Co., 1934.

THE CYCLOPEDIA OF MEDICINE. Edited by George Morris Petrol, B.S., M.D., assisted by Edward L. Borts, A.B., M.D. Vol. 11. Philadelphia: F. A. Davis Co., 1934.

THE SCIENCE AND PRACTICE OF SURGERY. By W. H. C. Ross, M.A., M.B., M.Ch. (Camb.), F.R.C.S. (Eng.) F.R.S. (Edin.) and Philip H. Mitchner, M.D., M.S. (Lond.), F.R.C.S. (Eng.) 5th ed. Vol. 1—GENERAL SURGERY. Vol. 2—RECONSTRUCTIVE SURGERY. Philadelphia: Lea & Febiger, 1934.

AMERICAN AND AMERICAN DYSMETRY. By Charles F. Craig, M.D., M.A. (Harv. Yale), F.A.C.P., F.A.C.S., Colonel, U.S. Army Retired, D.R.M. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1934.

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ATYPICAL GROWTH INDUCED IN CERVICAL EPITHELIUM OF THE MONKEY BY PROLONGED INJECTIONS OF OVARIAN HORMONE COMBINED WITH CHRONIC TRAUMA¹

MILTON D. OVERHOLSER, PH.D. M.D. AND EDGAR ALLEN, PH.D. COLUMBIA, MISSOURI
Department of Anatomy University of Missouri

THE ovarian follicular hormone has been shown by Allen (1927-1932) and by many others to be a powerful stimulator of epithelial growth in the female genital tract and breast.

Dingemans, Freud de Jongh, and Laqueur (1930) reported the presence of large amounts of the female sex hormone in the blood of cancer patients both male and female. Loewe, Raudenbusch, and Voss (1932) found increased amounts of the sex hormone in cancer tissue from men.

Lathrop and Leo Loeb (1916) found that ovariectomy of female mice markedly decreased the incidence of spontaneous mammary cancer. They said that their results demonstrated experimentally for the first time the significance of an internal secretion for the spontaneous development of cancer and that probably any factor which periodically induced increments in growth energy might be a factor in the development of carcinoma.

Cori (1927) reported that ovariectomy of female mice between the ages of 15 and 22 days entirely prevented the occurrence of spontaneous cancer of the breast, while the controls of the same strain showed a mammary cancer incidence of 78.5 per cent.

Murray (1928) by removal of the ovaries at 4 to 6 weeks of age in a cancer strain of rats,

reduced the incidence of mammary cancer from 80 per cent to 17.1 per cent. If the males of this same strain, who never developed mammary cancer, were castrated and a whole ovary of a sister transplanted subcutaneously, then these males developed spontaneous mammary cancer in 7.1 per cent of the cases.

Lacassagne (1932), using 3 young male mice from a strain in which only the females developed spontaneous mammary cancer, found that weekly injections of estrin in oil solution produced cancer of the mammary gland in all three males after 5 to 6 months of treatment.

Cook and Dodds (1933) reported estrus exciting activity to be possessed by the two most potent carcinogenic hydrocarbons yet known.

Zondek (1930) found the ovarian follicle stimulating hormone of the anterior pituitary in the urine of 81.8 per cent of women with genital carcinoma.

Hofbauer (1930) reported that anterior hypophysis transplants and extracts in guinea pigs produced a proliferation of the epithelium of the cervix into the subepithelial tissues which he considered to be a precancerous condition. His anterior pituitary treatment should have increased the production of the follicular hormone although he interprets his

¹This work has been assisted by grant from the Committee for Research in Problems of Sex of the National Research Council to Dr. Edgar Allen.

results as direct stimulation of the cervical epithelium by the pituitary hormone. He says Die Deutung dieser Versuchsergebnisse kann nur so lauten, dass der Hypophysenvorderlappen einen spezifischen stimulierenden Einfluss auf das Deckepithel der Portio vaginalis und zu einem gewissen Grade auf das Zylinderepithel der Cervix ausübt.

These facts led us (Overholser and Allen 1933) to study the changes produced in the cervical epithelium of the monkey by injections of genital growth hormones combined with chronic trauma.

MATERIALS AND METHODS

Nine *Macacus rhesus* monkeys were used. Seven were sexually mature and two immature. None of the animals had ever been pregnant so far as we know although some of them were shipped to us without past histories.

The cervixes were traumatized by scissors cuts through a vaginal speculum. This procedure was repeated at 7 to 10 day intervals throughout the experiment. In addition to the cuts a small metal clip was clamped on the cervix in some of the animals. Subcutaneous

injections of hormone were made twice daily morning and evening as a rule. The daily dose of estrin (ovarian follicular hormone) given as theelin¹ or amniotin² ranged from 50 to 360 rat units. The theelin preparation used contained 50 rat units per cubic centimeter. Two preparations of amniotin containing 200 and 50 units per cubic centimeter respectively were used. Four animals also received injections of corporin³ (a hormone of the corpus luteum) during the latter part of the estrin injections.

EXPERIMENTS

Monkey 1 This animal had been ovariectomized for some months previous to the experiment and the sexual skin was pale. The vaginal portion of the cervix was cut several times with a pair of scissors and the tissue squeezed tightly with a hemostat. On the following day injections of estrin were begun. In the first 17 days 1,660 rat units were injected.

Vaginal examination on the fourth and seventh days of the injections produced profuse hemorrhage from the cuts in the cervix and no additional trauma was made at these times. On the seventeenth day the sexual skin was red, the cervix appeared nodular and, as there was no bleeding, it was retraumatized. At this time all injections were suspended for 10 days. On the twenty-fourth day the sexual skin was still red, but examination revealed a stenosis of the vagina which prevented visualization of the cervix.

On the twenty-eighth day injections of estrin were begun again and in the following 62 days 3,830 rat units were injected.

Examination on the thirty first day showed a red sexual skin and a persistence of the vaginal stenosis.

¹Furnished by Parke-Davis and Company for experimental purposes.

²Furnished by E. R. Squibb and Sons for experimental purposes.

³Prepared according to method described by Turner, C. W. and Frank, A. H. M. *Am. Jour. Exp. Biol. Res. Bull.* 174, 1932.

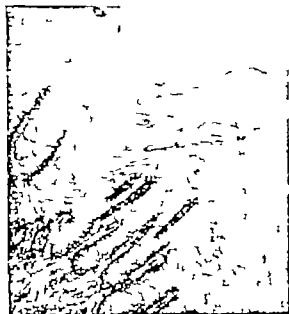


Fig. 1 Monkey 1. Section of cervix showing extreme hyperplastic condition of epithelium following estrin injections. $\times 77$



Fig. 2 Monkey 1. Section of vagina showing definite cornified layer of the epithelium and pigment granules in the basal layer of cells. $\times 300$

The stenosis was opened up with a knife and the vagina tightly packed with cotton. Seven days later (38th day) it was possible to view the cervix which was re-traumatized at this time the sexual skin was red.

On the forty fifth day a metal clip was clamped on the cervix. Examination 7 days later (52nd day) showed the clip still in place and the sexual skin very red. A week later (59th day) the clip was found loose in the vagina and was replaced on the cervix. The sexual skin was a bright red. Fourteen days later (73rd day) the metal clip was removed and several cuts made in the cervix, thus causing profuse hemorrhage. The clip was reapplied on the eightieth day.

Ninety days after the injections were started the animal was killed. It had been losing weight and strength during the last weeks of the experiment probably as a result of hemorrhage from the cervix. On the day of killing it was extremely emaciated and weak, being unable to rise. During the experiment a total of 5,490 rat units of castragenic hormone were injected.

Autopsy showed the metal clip still attached to the cervix, which was hypertrophied and nodular. Sections are shown in Figures 1 to 5. Figure 1 shows the extreme hyperplastic condition of the epithelium covering the vaginal portion of the cervix. This is the usual follicular hormone effect (Allen, 1927). Figure 1 is a section of the vagina and shows a definite cornified layer of the epithelium. Pigment granules are also present in the basal layer of cells.

Sections of the cervix taken near the junction of the stratified squamous with the columnar epithelium (Figures 3 and 4) reveal epithelial downgrowth



Fig 4 Monkey 1 Section of cervix showing epithelial downgrowth and overgrowth with epidermization of cervical glands $\times 50$



Fig 3 Monkey 1 Section of cervix showing epithelial downgrowth and overgrowth. Epidermization of cervical glands. Enlarged bulbous rete malpighii $\times 65$

and overgrowth, columnar gland cells being partially or completely surrounded with stratified squamous epithelium. Enlarged bulbous rete malpighii are also seen in Figure 3.

Figure 5 is a high power photograph of glandular epithelium surrounded by many layers of stratified squamous epithelium. As the latter increases in thickness the columnar cells of the gland are separated from their blood supply and degenerate. Nuclear variation is seen in the squamous cells, consisting of differences in size, shape, and staining reaction.

Monkey 2. This animal had been ovariectomized for some months previous to the experiment and the sexual skin was pale. The cervix was traumatized and on the following day injections of estrin were



Fig 5 Monkey 1 Glandular surrounded by stratified squamous epithelium. Variation in size and staining reaction of the nuclei is seen. $\times 340$



Fig. 6 Monkey 2. Section of cervix at junction of stratified squamous with glandular epithelium. Epithelial hyperplasia resembling a leukoplakia. $\times 77$

begun. In 17 days 1,660 rat units were given. The injections were then stopped and 3 days later (30th day) the animal was killed.

On the fourth and seventh days the cervix was retraumatized. The actual skin was very red on the seventeenth day when the cervix was again traumatized.

At autopsy the cervix was hypertrophied and irregular. Sections of the cervix are shown in Figures 6 and 7. Figure 6 taken at the junction of the stratified squamous with the glandular epithelium shows a marked epithelial hyperplasia resembling a leukoplakia. Squamous epithelium surrounds columnar cells and there is marked downgrowth and irregularity of the rete malpighii. A round cell infiltration is seen in the connective tissue.

Figure 7 is a high power view from Figure 6. Three glandular tubules of columnar cells are completely surrounded with stratified squamous epithelium.

Monkey 3. This animal was ovariectomized, the sexual skin being moderately red at the time. On the sixth day after ovariectomy the cervix was traumatized and a metal clip clamped on it. Cervical trauma was repeated on the twelfth day, the sexual skin being pale at this time. Injections of estrin were started on the twenty first day, beginning with 40 rat units daily and increasing to 90 rat units daily in 17 days. Eight days after injections were started the sexual skin was red and remained so throughout the experiment. On the sixty ninth day (48 days of injections) the estrin was stopped after 3,047.5 rat units had been given. Fourteen cubic centimeters of corporin were then given in the next 8 days, 800 rat units of estrin being given with it. A total of 4,747.5 rat units of estrogenic hormone were therefore injected during the experiment.

Cervical trauma was repeated on the twenty second, twenty ninth, fortieth, fifty first, sixtieth, sixty eighth and seventy seventh days. The metal



Fig. 7 Monkey 2. A high magnification from Figure 6. Three glandular tubules of columnar cells completely surrounded with stratified squamous epithelium. Infection present. $\times 300$

clip remained on the cervix throughout the experiment. Four days after all injections had been stopped (81st day) the animal was killed.

At autopsy the cervix was very nodular and irregular with several necrotic areas. Figures 8 to 10 show sections of the cervix. An ulcerating area was found in which there was marked downgrowth of the epithelium with formation of many isolated epithelial nests (Fig. 8). A high power photograph of this region is shown in Figure 9. The borders of the epithelial masses are irregular with no basement membrane. The nuclei vary in size and shape and are hyperchromatic. A gland like lumen is seen containing a few leucocytes and epithelial cells. Leucocytes are also seen in the connective tissue.

Figure 10 shows an area of epithelial downgrowth and gland overgrowth with atypical epidermization. The columnar cells are undergoing degeneration. This is a duplication of the condition usually diagnosed as a precancerous lesion in human material.

Monkey 4. This animal was ovariectomized, the sexual skin being very red at the time. Injections of estrin were begun 22 days later, starting with 40 rat units daily and increasing to 90 rat units daily in 13 days. After 1,002.5 rat units of estrin had been injected in 15 days it was stopped and 10.7 cubic centimeters of corporin were then injected in the next 8 days. Injections were then discontinued for 23 days, following which 1800 rat units of estrin were given in 5 days. All injections were then stopped and the animal was killed 33 days later. During the 51 day injection period a total of 2,803.5 rat units of estrogenic hormone and 10.7 cubic centimeters of corporin were injected.

No cervical trauma of any kind was given to this animal.

At autopsy the cervix appeared slightly irregular. Sections showed an extensive area of papillary gland overgrowth, much epidermization and many areas of distinctly atypical epidermoid cells (Figs. 11 and 12). As there was also much infection it is probable that some old cervical injury was present.



Fig. 8. Monkey 3. Section of cervix showing epithelial downgrowth and presence of isolated epithelial nests in an ulcerating area. $\times 50$

Monkey 5 This animal had been ovariectomized several months previous to the beginning of the experiment. The cervix was traumatized and 2 days later injections of estrin were begun and continued for 16 days, when the animal died. A total of 1,535 rat units of estrogenic hormone were injected. The cervix was retraumatized three times during this period.

At autopsy the cervix appeared somewhat nodular and hypertrophied, with several necrotic areas. Sections of the cervix showed a very hyperplastic epithellum indicating that the hormone treatment had been effective. A few areas of columnar epithellum surrounded by stratified squamous epithellum were present but this condition was not developed to such a degree as found in the other experiments that extended over longer periods of time.

Monkey 6 This was a young immature animal the sexual skin being slightly pink. A double ovariectomy was performed and 3 days later the cervix was traumatized, a metal clip being also clamped on it. Cervical trauma was repeated on the eleventh day following the operation, the sexual skin being pale at this time.

On the twentieth day injections of estrin were started, beginning with a daily dose of 40 rat units which was increased to 90 rat units by the seventh day. After 1,125 rat units had been given in 20 days, injections of corporin were begun, 16.5 cubic centimeters being given in the next 20 days. Thirty-two hundred rat units of estrin were injected along with the corpus luteum hormone. Injections were then stopped and the animal killed 12 days later (80th day). A total of 4,312.5 rat units of estrogenic hormone were injected.



Fig. 9. Monkey 3. Higher magnification of Figure 8. Epithelial masses are irregular with no basement membrane. Hyperchromatic nuclei. $\times 250$

The cervix was retraumatized on the twenty-first, twenty-eighth, thirty-ninth, fifty-ninth, and sixty-seventh days. From the thirty-ninth to the fifty-ninth day the clip was not on the cervix. The sexual skin was moderately red after the ninth day of injections and remained so throughout the injection period.

At autopsy the cervix was nodular. Sections showed a sloughing of the superficial epithellum.



Fig. 10. Monkey 3. Section of cervix showing a condition usually diagnosed in women as precancerous. $\times 50$



Fig. 11. Monkey 4. Section of cervix from animal that received hormone injections only. Papillary gland overgrowth, much epidermization and areas of atypical epitheloid cells. $\times 85$.

although in many regions of the cervical canal glandular cells were surrounded by stratified squamous epithelium. A large proportion of the vaginal epithelium had also been sloughed, but intact areas were in a hyperplastic condition, indicating that the hormone treatment had been effective. The sloughing of the epithelium in this animal was no doubt caused by severe infection.

Monkey 7. This was also a young, immature animal, the sexual skin being slightly pink. A double ovariectomy was done and 5 days later the cervix was traumatized, a metal clip being also clamped on it. Cervical trauma was repeated on the eleventh day following the operation.

On the twentieth day injections of estrin were started, beginning with a daily dose of 40 rat units and increasing to 90 rat units in 18 days. Injections were continued for 53 days, a total of 4,267.5 rat units being given. Eight days after the beginning of the estrin injections the sexual skin was slightly swollen; at 35 days it was moderately red; and at the end of the 53 days it was extremely red. Twenty-five cubic centimeters of corporin were given in the next 8 days. All injections were then stopped, and the animal killed 43 days later (132nd day). By the sixteenth day after the stopping of all injections the sexual skin was pale and remained so.

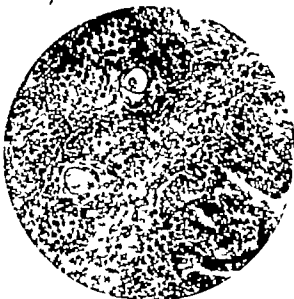


Fig. 12. Monkey 4. Higher magnification of Figure 11 showing atypical cells. $\times 205$.

The cervix was retraumatized on the twenty-first, twenty-eighth, thirty-ninth, fiftieth, fifty-ninth, sixty-seventh, seventy-sixth, eightieth, ninety-sixth, and one hundred and thirteenth days. On the ninety-sixth day when the cervix was cut about 2 cubic centimeters of thick pus ran out. On several occasions the clip was found loose in the vagina but was resipped each time.

At autopsy the cervix appeared white and nodular. Sections showed an atrophic sloughing epithelium. The vaginal epithelium was also atrophic. The uterus, removed at the time the injections were stopped, showed a hyperplastic condition of the endometrium. Since this animal was killed 43 days after all injections were stopped, the atrophic condition of the epithelium would be expected. The sloughing was no doubt caused by severe infection.

Monkey 8. This animal was a normal control with both ovaries intact. Cervical trauma only was given—no injections of any kind being made. The cervix was traumatized and a metal clip clamped on it. The trauma was then repeated on the eighth, eighteenth, twenty-fifth, thirty-sixth, forty-seventh, fifty-sixth, sixty-fourth, seventy-third, eightieth, ninety-third, and one hundred and tenth days. The animal was killed on the one hundred and nineteenth day. The metal clip remained on the cervix throughout the experiment. The sexual skin was very red at the beginning of the experiment and remained so, indicating that the ovaries were actively secreting hormone throughout the experiment.

At autopsy the cervix was moderately nodular. Sections showed a few areas of columnar epithelium partially or completely surrounded by stratified squamous.

Monkey 9 This animal was an ovariectomized control. Both ovaries were removed, the cervix traumatized, and a metal clip clamped on it. No injections of any kind were given. Cervical trauma was repeated on the eighth, eighteenth, twenty fifth, thirty sixth, forty-seventh, fifty sixth, sixty fourth, seventy third, and eightieth days. The animal was killed on the eighty-sixth day. The sexual skin was pale throughout the experiment.

Sections of the cervix showed an atrophic epithelium at no place was columnar epithelium either partially or completely surrounded by stratified squamous (Fig 13). Sections of the vagina and uterus also revealed an atrophic epithelium such as would be expected in an ovariectomized animal.

There is no agreement among pathologists who have examined our sections as to the exact significance of the epithelial changes produced in these experiments. In a preliminary publication (Overholser and Allen, 1933) it was stated that conditions resembling early cancer had been produced (Monkeys 3 and 4) based on the opinion of a well known pathologist. It appears that as yet there is no generally accepted definite criterion for the positive diagnosis of very early cervical cancer and that this accounts for the difference of opinion on this subject among pathologists.

The present confusion regarding the diagnosis of the precancerous state of the cervix uteri has been recently reviewed by Freedman (1934). He points out that the exact histological definition and diagnosis is still a matter of personal interpretation. Freedman presents sections of human cervical tissue that show excessive atypical overgrowth of new squamous cells along the walls of cervical glands and ducts that are exactly comparable to the conditions produced in these experiments. (See Figs. 3 to 12.) He calls this condition "carcinoid" in preference to the term "precancerous" and states as follows "The fact that we find it impossible to lay a perfect formula for the precancer stage does not preclude its existence. Study of the histogenesis of cancer would prove that there is such a precursory stage call it by whatever name is desirable. The fact that not all of these carcinoid tissues go on to actual cancer does not detract from their importance in the prevention of cancer, and a guarded attitude should be taken, frequent local examinations with biopsies to ascertain any progress toward malignancy



Fig 13. Monkey 9. Section of cervix from ovariectomized animal receiving only cervical trauma. Junction of stratified squamous epithelium with columnar cells. Atrophic epithelium. X55.

should be undertaken if necessary. This is probably the only way to distinguish those carcinoid conditions that will surely turn to malignancy later."

We have therefore been able to produce experimentally in the monkey a condition that occurs in the human cervix uteri. We believe that the squamous epithelium found around the columnar gland cells has arisen by a metaplasia of the columnar cells. We have not observed mitotic figures in either the columnar or squamous cells. This is probably due to the fact that the tissue was not taken at the particular time when mitosis was occurring.

Dr E. T. Engle, of Columbia University, has also observed areas of squamous cells associated with columnar gland cells in the cervixes of monkeys receiving only estrin (Amnionin in oil) injections.¹ His animals received daily injections for several months and the cervixes were not traumatized.

It should be possible by repeating these experiments and extending them over much longer periods of time to determine experimentally whether the changes in question will or will not develop into cancer in the monkey. Either result would be highly important and experiments are now being carried out with a view to demonstrating this point. To what extent the various experimental factors such as trauma, estrin and corporin respectively are responsible for the results obtained also needs further analysis.

SUMMARY

Atypical epithelial growth in the cervix uteri of 4 ovariectomized monkeys (Monkeys 1 to 4) was experimentally produced. The changes consisted of marked squamous epithelial downgrowth, overgrowth and epidermization of the cervical glands in the region of the junction of the stratified squamous with the columnar epithelium. The treatment these animals received was as follows:

Monkey 1 received 5,490 rat units of estrin in 90 days with repeated cervical trauma.

Monkey 2 received 1,660 rat units of estrin in 20 days with repeated cervical trauma.

Monkey 3 received 4,747.5 rat units of estrin and 14 cubic centimeters of corpus luteum extract in 81 days with repeated cervical trauma.

Monkey 4 received 2,802.5 rat units of estrin and 10.7 cubic centimeters of corpus luteum extract in 84 days. This animal did not receive cervical trauma and the changes were very pronounced (Figs 11 and 12) the epithelial cells being very atypical.

In three monkeys the results were practically negative possibly due to the following reasons: (1) injection period too short (Monkey 5); (2) sloughing of epithelium from severe infection (Monkey 6); (3) sloughing of epithelium from infection and from stopping hormone injections 42 days before sacrificing animal (Monkey 7).

A normal control (Monkey 8) receiving trauma only showed a slight amount of epidermization of cervical glands.

An ovariectomized control (Monkey 9) receiving trauma only was completely negative.

BIBLIOGRAPHY

1. ALLEN, EDGAR. The menstrual cycle of the monkey *Macacus rhesus*: observations on normal animals, the effects of removal of the ovaries and the effects of injections of ovarian and placental extracts into the spayed animals. *Contrib. Embryol. Carnegie Inst. Wash.* 1927, no. 98, 191.
2. Idem. *Sex and Internal Secretions*. Baltimore: Williams & Williams Co. 1931.
3. COOK, J. W., and DOODS, E. C. Sex hormones and cancer producing compounds. *Nature*, 1933, 131: 205.
4. COOK, CARL F. The influence of ovariectomy on the spontaneous occurrence of mammary carcinomas in mice. *J. Exper. Med.* 1937, 45: 683.
5. DRUGMAYER, C., FREUD, J., DE JONGH, S. E., and LAQUEUR, ERNST. Ueber das Vorkommen von boesen Mengen weiblichen (Sexual-) Hormons. *Abhandlungen des Vort. von Krebskranken (Männern)*. Arch. f. Gynaek. 1930, 141: 223.
6. FRIEDMAN, NATHAN. "Precancer" of the cervix uteri, some pertinent observations on its status. *Surg. Gynec. & Obst.* 1934, 58: 717.
7. HOFBAUER, J. Kausale Faktoren der genitalen präcancerösen Veränderungen. *Zentralbl. f. Gynaek.* 1930, 54: 2393.
8. LACABROUX, M. A. Apparition de cancers de la mamelle chez la souris stérile soumise à des injections de folliculine. *Compt. rend. Acad. d. sc.* 1931, 195: 630.
9. LATHROP, A. E. C., and LOEW, LEO. Further investigations on the origin of tumors in mice. III. On the part played by internal secretion in the spontaneous development of tumors. *J. Cancer Res.* 1916, 1: 1.
10. LOEW, S., RAUDENBACH, W., and Voss, H. F. Sexualhormongehalt von Krebsgewebe. *Biochem. Ztschr.* 1933, 249: 443.
11. MURRAY, WILLIAM S. Ovarian secretion and tumor incidence. *J. Cancer Res.* 1936, 13: 18.
12. OVERHOLSER, MILTON D., and ALLEN, EDGAR. Will prolonged injections of ovarian or pituitary hormones combined with chronic trauma produce a precancerous condition in the cervix of the monkey. *Anat. Rec.* 1933, 55 (No. 4, Suppl.): 37.
13. Idem. Ovarian hormone and traumatic stimulation of monkey cervix to a condition resembling early cancer. *Proc. Soc. Exper. Biol. & Med.* 1933, 30: 1322.
14. ZONDER, B. Ueber die Hormone des Hypophysenvorderlappens. III. Follicelreifeungshormon (Prokin A) und Tumoren. *Klin. Wchnschr.* 1930, 9: 679.

THE ORIGIN OF PILONIDAL SINUS

WITH AN ANALYSIS OF ITS COMPARATIVE ANATOMY AND HISTOGENESIS

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THIS paper records the results of a study of pilonidal sinuses (also known as sacrococcygeal fistulae) and presents evidence that they are derived by a process of ectodermal invagination.

Contributions to the nature and origin of pilonidal sinuses have been few and are chiefly by investigators on the Continent. Couraud 1883, Stone 1924 (37), and Weinstein 1933 in reviewing the literature found that J. M. Warren was the first to report this lesion. Warren described two cases and believed that the lesion was the result of an alteration of the polarity of growth of the hair follicle which grew inwardly from the surface and pulled "its hole in after it." This idea was purely hypothetical and lacked any embryological basis. Hodges 1880 who gave to the condition the name pilonidal sinus (meaning nest of hair) also advanced a theory that this affliction was due to the ingrowth of hair in the postanal region as the result of unclean habits and erosion of the skin. Wendelstadt, quoted by Stone (37) and Ewing reported a case containing skin and hair, and he believed that the hair acted as a plug causing the retention of infected material in a fistulous tract. Vaughan Gross and others also held to the belief that the anomaly followed interception or inclusion by the integument of surface hair follicles. The earliest writers advised surgical excision for treatment.

THE NEUROGENIC THEORY

At present there are two prevalent theories as to the causation of pilonidal sinus: first, that which traces the origin of the condition to a persistence of coccygeal vestiges of the neural canal and second that which derives the lesion by a process of ectodermal invagination. The adherents of the former theory are in the majority. On the Continent the first to advocate this thesis were Tourneux and Herrmann in 1887. These investigators made sec-

tions through the sacrococcygeal region of human and chick embryos and came to the following conclusions which have been widely read and generally accepted. In young embryos the spinal cord at first extends to the tip of the vertebral column and becomes attached to the skin caudally. At the end of the third month there is a considerable inequality in growth between the medullary tube and vertebral column which results (due to the elongation and downward thrust of the latter) in drawing the spinal cord upward in cephalad direction. The stretched distal portion though still adherent to the skin, and continuous in structure with the rest of the spinal cord (Kunitomo 1) becomes divided into two segments: a "direct" part and a caudal or "reflected" part.² By the fifth month the proximal or "direct" portion has atrophied and disappeared and the "reflected" portion becomes separated from the central nervous system. This vestige becomes converted into a tubular structure lined with columnar or polyhedral epithelial cells to which the authors give the name "coccygeal vestiges of the medullary tube." This structure reaches its maximum development in the fifth month and subsequently undergoes progressive atrophy. Tourneux and Herrmann believed that the failure of these coccygeal medullary vestiges to atrophy was the etiological factor in the formation of congenital sacrococcygeal tumors and sinuses.

The next important contribution on this subject was made by F. B. Mallory in 1892. Mallory in a review of the literature attempts to reconcile the various viewpoints and presents microtome sections of several embryos from 3 to 6 months old. He found rather consistently a tubular structure lined with several layers of columnar or cuboidal epithelial cells lying between the coccyx and the skin in

According to Kunitomo the separation between the main part of the cord and the distal end which eventually forms the filum terminale, takes place at about the level of the thirty-second vertebra.

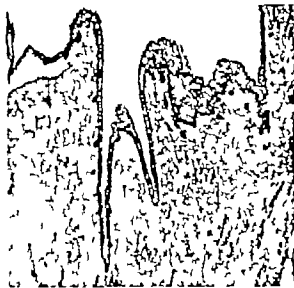


Fig. Path No. 5806 Photomicrograph of a section through the caudal extremity of a white female, 99 millimeter embryo (4 3/4 weeks). Note the invaginations and the thickened epithelium in this region. The clusters of cells beneath the epidermis later differentiate to form hair follicles and glands.

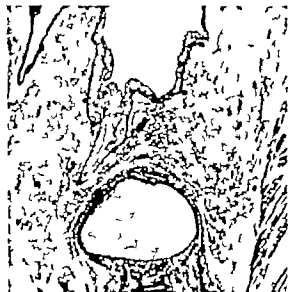


Fig. 2 Path. N. 51806 Photomicrograph of a section through the same embryo shown in Figure 1 but at a slightly higher level. Note how closely the invaginating process approximates the coccyx. The intervening tubular structure is a portion of the coccygeal vestiges of the primitive neural tube.

the median line. This canal lay in a region studded with glands and hair follicles and where ectodermal invaginations were a common and predominant feature in the development and regression of this portion of the human tail. Mallory also came to the conclusion that the congenital depressions, dermoid cysts and sinuses found in the midline of the sacrococcygeal region arose from the persistence of medullary vestiges of the spinal cord. The clinical finding of hair within the recesses of these sinus tracts was vaguely explained by the presence of neighboring dermoids or the migration of surface hair and foreign accumulations.

Oehlecker in 1926 also investigated these coccygeal vestiges of the neural tube. His conclusions concerning the formation of pilonidal sinuses and cysts were as follows: Due to the rapid growth of the caudal or non-vertebral portion of the cauda the caudal ligament puts traction on the thin hairless areas of skin overlying it in the sacrococcygeal region. This traction is increased as the subcutaneous fat in this area grows and the caudal ligaments simultaneously become shortened.

As a result of this traction the margins of the surrounding skin containing hair follicles are also to some degree invaginated. The skin overlying the rapidly growing vertebrae being unable to keep up with the downgrowth of the vertebral column is displaced posteriorly and upward as is also the tip of the caudal ligament. By the fourth or fifth month the skin which originally covered the tip of the coccyx is drawn upward so as to lie over the third or fourth caudal vertebra and later goes higher. (The point where the caudal ligament radiates into the skin makes a very thin hairless, vascular area which he calls sacral bald spot.) The normal products of the skin metabolism readily accumulate to form cysts or discharge intermittently as fistulae.

Thus the writer presupposes the coexistence of hairless and hair containing integument in the same region and a special migration upward of neurogenic elements having lost their maternal connections and possessing no fixed point of attachment such as the spinal cord has with the brain at the foramen magnum. If one supposes that the fixation point is the skin then the direction of the pilonidal



Fig. 3 Path. No. 52002. Photomicrograph of a section through the coccygeal region of a white female, 101 millimeter embryo (15 3/4 weeks). The coccygeal medullary vestige is fully developed and lined with columnar epithelium. The ectoderm however is only slightly thickened and its appendages have not yet begun to appear.

sinus should be downward instead of upward which is not the usual clinical finding as shall be explained later

THE THEORY OF ECTODERMAL INVAGINATION

The earliest proponents of this theory thought that pilonidal sinus was due to a dermoid cyst. Lannellongue is quoted by Mallory as follows: 'After the medullary canal is formed, the mesoblast passes back between the vertebral column and the external epidermis except in the region of the sacrum where little of this tissue is interposed so that this region is reduced to epidermis and bone. Consequently the superficial layer (epiblast) joined at a later period to the mesoblast preserves closer relations with the bone and later when the subcutaneous tissue is developed around these places a depression will be formed. If deep and narrow enough the orifice may close up and a dermoid cyst be the consequence.'

One of the first constructive contributions to the theory of ectodermal invagination as the cause of pilonidal sinus was made by Stone. In his first paper (37) in 1924 he reported 61 cases of which all were white, 16 per cent female and the oldest was 49 years



Fig. 4 Path No. 52000. Photomicrograph of a section through the coccygeal region of a white female, 132 millimeter embryo (17 1/4 weeks). Note the papillary folds of thickened ectoderm and the numerous clusters of cells in back of the coccyx.

and the youngest 18 years of age. Twenty-five cases had previous operations and some sinuses were of 10 to 20 years' duration. Following a personal communication with Dr. George L. Streeter of the Carnegie Institute of Washington, Baltimore, Maryland, Stone came to the conclusion that the coccygeal medullary vestige, which has no opening communicating with the skin, consists of cells which have become so differentiated that they could not be expected later to give rise to skin even though a cystic remnant should persist and that like the breast and the external ear the pilonidal sinus is due to a special local downgrowth of epithelium originating from the true skin and not from the medullary groove.

In 1931 Stone (38) in another paper upon the subject made the following observations: First that in a few cases there were several congenital orifices, skin lined and lying close together in or near the midline. Second he



Fig. 5 Path N 380 Photomicrograph of a section through a colored male, 68 millimeter embryo (30½ weeks) in the region of the coccyx. Note the persisting invagination and the developing hair follicles and glands (The medullary vestiges are present, but are not seen in this figure.)

discovered that in many species of birds there is described a preen or oil gland called uropygial gland which lies embedded in the subcutaneous fat over the last caudal vertebra. It consists of numerous straight tubules which converge and empty into a collecting chamber or small cavity which in turn empties through an epithelium lined duct onto the skin of the back. At the mouth of the duct there is often a tuft of fine hair-like feathers. There may be several ducts (1 to 6 in number) and they lie in or near the posterior midline. The gland secretes an oily material which the bird conveys by its beak to stroke on its feathers and the duct is directed in an upward direction like the pilonidal sinus in the human. This view quoted by the author from Lunghetti and Schumacher is contended by Paris, who states that these are special scent glands concerned with protection and sexual attraction. According to

Paris, all amniotes, reptiles, and mammals as well as avians, have similar structures which are formed by inward budding invaginations of epithelium.

Thus, while a general agreement exists that some vestigial structure or anomaly in the embryo is responsible for the origin of pilonidal cysts its exact nature is a matter of dispute. A re-study of the sacrococcygeal region was therefore undertaken in human embryos to see if some structure could not be identified and more definitely associated with the lesion. Serial sections were made in seven embryos¹ through the caudal extremity from the anus to the region of the sacrum. Grossly in the region just dorsal and cephalad to the anus in a 3½ months fetus, there could be seen with the naked eye and with low power lenses a pattern of grooves and creases which might well be taken for ectodermal invagination. A pit could be demonstrated in the 5½ months old embryo which was much deeper in the older specimens.

The first embryo was a 99 millimeter (14½ weeks) white female specimen. The activity of the invaginating ectoderm was very striking (Fig. 1). The epithelium in this region was markedly thickened and at various points beneath the epidermis clusters of budding epithelium or growth centers, could be seen. These were in the process of differentiating to form hair follicles and glands of the integument, and were particularly active opposite the points of invagination. In Figure 2 which includes a portion of the coccyx the peak of the invaginating process closely approximated the bone. Here also in the midline between the coccyx and the skin there was a tubular structure lined with columnar cells which was a portion of the coccygeal medullary vestiges (primitive neural tube).

This vestigial neural structure was more strikingly demonstrated in Figure 3 which is a section through a 101 millimeter (15½ weeks) white female embryo. Although this specimen was somewhat older than the preceding one there was nevertheless a definite lag in growth and the skin appendages had

¹ These embryos were obtained for me through the kindness of Dr. Caspary who in return I am indebted for his generous assistance and advice. The specimens were given to the laboratory by Dr. George L. Stricker who also kindly co-operated in this study.



Fig. 6 Path. No. 52148 Photomicrograph of a section through the coccygeal region of a white male, 214 millimeter fetus (27½ weeks). The invaginating process is shown directly impinging upon the coccyx, and the skin appendages are very numerous and well developed.



Fig. 7 Path. No. 52148 Photomicrograph of a section through the same fetus shown in Figure 6, but at a slightly higher level. Note the activity of the pilonidal cleft and compare with the fragmented degenerating medullary vestiges.

not yet begun to develop. There was only a suggestion of infolding and thickening of the ectoderm but the neural rests were larger and nearly completely developed. There seemed to be no relationship in these specimens between the development of the medullary vestiges and the process of ectodermal invagination. In the third specimen the skin could be seen in a further stage of differentiation while the neural rests remained practically unchanged. The ectoderm was markedly thickened and thrown into papillary folds, and the skin appendages were beginning to cluster in back of the coccyx (Fig. 4).

The invaginating process persisted at 20½ weeks (Fig. 5) and the hair sheaths with their keratin centers were more prominent. (The medullary vestiges though present are not shown in this figure.) It is evident that ectodermal invagination in this region varies in form and degree with different embryos. In

other words it does not proceed in graded steps in accordance with age in the first few months of embryonal development. However, at 27½ weeks (Fig. 6), or just before viability the invagination increases in depth and impinges directly upon the coccyx and is prominent at this time. The skin appendages are now very numerous and well developed. (The surgical importance of this anatomical relationship will be stressed later.) At this stage the ectodermal layer is twenty-five cells deep in contrast with the adjacent skin which is four to five cells in thickness. The hair follicles are also three to four times as abundant in the region of invagination. The medullary vestiges, however, are fragmented and the epithelium is degenerating (Fig. 7).

At 29½ weeks or after viability the specimen showed only slight evidence of the pilonidal cleft or pit of invaginated ectoderm



Fig 8. Path No 5315. Photomicrograph of a section through the coccygeal region of a white female, 268 millimeter fetus (20 weeks). The pilonidal cleft is shallow and the neural rests are being obliterated by an apparent ingrowth of fibroblasts and blood vessels.



Fig 9. Path No 5352. Photomicrograph of a section through the coccygeal region of a white female, 226 millimeter embryo (26 weeks). Note the epithelial spur and the thickened ectoderm.

This may be due to the lack of development but is very probably due to a recession of the invaginating process. On the other hand the neural rests are being obliterated by an apparent new growth of fibrous tissue and an ingrowth of blood vessels (Fig 8). Curiously one specimen at 26 weeks showed a spur—between two invaginations of the ectoderm on either side (Fig 9). This brings to mind Lawson Tait's reference to the 'human tail' but the resemblance is undoubtedly imaginative. In no specimen were the neural rests found to communicate with the spinal canal although one could follow them through 125 to 400 serial sections, each 7 microns in thickness.

In the chick embryo in the region of the sacrum may be seen an invagination of ectoderm forming the *glande du croupion* (40). This analogy is merely suggested and not stressed. At this writing it is desired only to present evidence that the forerunner of the

pilonidal sinus may be a specialized and transient skin appendage in the human the function and homologues of which in other species are as yet undetermined. Lawson Tait quoted by many authors, said that the sinus was due to the loss of a caudal appendage (human tail?) but made no mention of a skin appendage.

CLINICAL OBSERVATIONS

The clinical findings corroborate these embryological data and one does not have to presuppose any special excursion of neurogenic elements or escalator migration of ectoderm over the bony coccyx.¹ In the first place pilonidal sinus is undoubtedly a congenital lesion although it becomes clinically evident practically always after the middle of the second decade. Rarely a case has been reported in infants (28-35).

¹Dr. Swenson states that there is no definite proof of the fact that skin migrates in this fashion over the sacrococcygeal region. *Personal communication, October, 1951.*

The initial symptom usually follows trauma or the transmission of a superficial infection. The patient states that he has noticed "for some time an intermittent staining of his clothes or foul discharges near his rectum." Localized tenderness and pain are common but systemic reactions such as high fever, nausea and vomiting, chill and malaise are rarely found. These have occurred in cases associated with meningitis (see later discussion). Uninfected pilonidal cysts are almost never found in routine examination—in over 70 cases in the present series all show various degrees of inflammation. A physical examination may reveal the sinus in cases in which the symptoms are so mild and the inconvenience so slight that the patient "never bothered about it." The external opening is found usually in the midline in the region of the sacrococcygeal joint. It is smooth, skin lined, and from its mouth there may be seen fine hairs projecting outward. If the lumen is irregular and covered with granulations, it means that there has been previous operative intervention, or that it is an adventitious opening in which case another point of entrance is to be suspected. Several congenital orifices are not uncommon and they may vary in size from a pin point to about 0.5 centimeter in diameter. These cases may be explained by the fact that the pilonidal cyst may communicate with one or more of the ectodermal invaginations (Fig. 2). Signs of inflammation such as swelling, redness, induration and tenderness may be present and one may express drops of thin, dirty foul pus upon exerting pressure over the tract. When probed the sinuses vary in length and depth and may reach the bone beneath. The direction is usually upward which is a differential point in distinguishing the lesion from fistula in ano, which is directed downward.

Superficial hair follicle abscesses and deep suppurations of bone with severe systemic reactions can be easily ruled out. Venereal tuberculous and neoplastic lesions of the bony parts, of the anus or rectum may be readily dismissed by rectal or sigmoidoscopic examination and by the fact that pilonidal sinus is essentially a benign lesion with benign symptoms. Likewise malignant infections like



(Fig. 10. Sacrococcygeal neuro-epithelioma (glioma) (from Roussy et Oberling, *Atlas de Cancer*, Aug. 1931). The upper figure consists of cylindrical-cuboidal cells which line vascular spaces containing red blood corpuscles. In the lower figure the cells are stratified and possess fibrillary extensions. These bundles represent neuroblastic differentiation in the tumor tissue.

anthrax and actinomycosis and deep burrowing fistulous tracts may be ruled out.

The treatment of pilonidal sinuses is not within the scope of this paper, numerous recent articles have covered this phase of the subject.¹ The essential principle is block dissection with drainage, with or without partial primary suture. Location of adventitious branches is facilitated by the injection of the sinus tract with a mixture of methylene blue and hydrogen peroxide in equal parts (Stone 38).

PATHOLOGY

The pathology is best illustrated by describing a case of a medical student 27 years of age who was recently operated upon by Dr. Stone. The specimen when received was 12

Nelson's Surgery, 20; Lewis's Surgery 21; Lacey 10; Stone, 37; Boerje, 3; Cattell and Seiler 7; Dulligan, 10; Landman, 10; Beckman 5; Weinstein, 44; Cole, 8; Mason, 27. Dr. Stone uses hydrogen peroxide to destroy the adventitious tracts (personal communication).



Fig. 1. Path No. 844. Photomicrograph of a sacral teratoma in a white female infant (age 1 day). It consists of numerous glands embedded in a delicate stroma of connective tissue. There are also adult and fetal cartilage, intestinal and bronchial epithelium, liver, brain, and neuroblastic tissue. A topey performed.

by 2½ by 2 centimeters. In the center was a large bifurcated opening leading into a tubulous tract which tunneled the entire specimen. At each end was an opening, one of which entered the main tract and the other led into a blind pouch of its own. These drainage points were irregular and surrounded by granulation tissue and obviously secondary in nature.¹ There were however two additional congenital lumens with smooth surfaces, and each leading like a flask into a sac filled with hair and possessing a gelatinous lining. The hair was fine, silky and lighter in color than the body hair. The main tract was lined with a velvety thin mucoid substance and contained long dark thick hairs. There was no frank pus and there were no hairs growing from the walls of the sinuses leading to the skin.

¹ Patient had previous operation for pilonidal sinus in which two adventitious tracts were missed.



Fig. 2. Path No. 51574. Photomicrograph of a chorodoma in a white female 61 years old. The tumor consists of large, round, vacuolated, hyperchromatic cells growing in a syncytial fashion and strongly resembling hyaline cartilage. The patient died with recurrence.

Histologically the picture of this and other cases is essentially the same. Usually the main tract consists of granulation tissue rich in blood vessels and exudate of a subacute inflammatory nature. There are some polymorphonuclear leucocytes, giant cells, and deposits of blood pigment but predominating are large numbers of wandering cells—plasma cells, monocytes and lymphocytes. Lying loosely in the stroma are numerous hairs without sheaths surrounded by giant cells. This is a very characteristic finding. Elsewhere one finds fully developed hair follicles and sweat glands. The adventitious branches are lined with stratified squamous epithelium like skin but nowhere does one see the characteristic circumscribed structure of a dermoid. In fact, I have never seen a pilonidal sinus contain the cheesy substance or the compressed epithelial lining and keratin

center of an epidermoid or subepithelial dermoid cyst.

INCIDENCE AND POSTOPERATIVE RECURRENCES

Recurrences in cases of pilonidal sinuses are not uncommon. Most of them are due to the lack of understanding of the embryology and pathology of the disease with the result that incision and drainage is performed which is obviously inadequate. Stone¹ believes that recurrences should not exceed 5 to 8 per cent in good hands.

Cattell and Stoller from the Lahey Clinic report 59 cases with 9 recurrences in 40 traced cases. Six of these were cured by second operation. Landsman states that there are about 20 per cent recurrences in infection of the sacrococcygeal region. Stone (37) reported 61 cases from the Johns Hopkins records and private practice of which there were 25 recurrences. One patient had 8 or 10 previous operations. Dulligan reports 25 cases in 25,000 admissions at St. Mary's Hospital, Brooklyn, N. Y. It was his opinion that sacrococcygeal cysts were the result of congenital invagination of ectoderm with all its appendages, which if complete formed a cyst, and if incomplete formed a sinus or fossa. Masson reported 81 cases from the Mayo Clinic, during a 5 year period, of which 25 had multiple openings but he does not state how many were recurrences. (Fifteen per cent in this series were females and the age group ranged from 16 to 57 years. There was 1 case in an infant of 19 months but this was not described.) Masson states that trauma was a frequent finding in the history of these patients. Weinstein reported 13 cases, 85 per cent males and ranging from 17 to 39 years.

Weeder, in a recent article, states that 25 to 35 per cent recurrence occurs in the best hands. This figure is probably too high for present day methods of treatment. This writer believes that if the theory of simple ectodermal invagination were true then all pilonidal sinuses should be cured by the first operation. But this is not as simple as it seems because there may be numerous congenital or adventitious tracts leading from the cyst the entrance of which may be at the

time closed off to any injection of methylene blue and which may be missed with the naked eye. Weeder believes that recurrences are due to the inclusion within the sacrococcygeal junction of a part of the cyst, derived from the unobliterated portion of the medullary canal, during the process of fusion of the dorsal arches which may or may not be complete (spina bifida occulta). He noted that when he injected these cases with methylene blue the surface of the joint and occasionally even the deeper structures were discolored. In these cases, therefore, he recommends excision of the coccyx and curettage of the sacral stump. This procedure was performed in 4 cases, yet in none of these was there any mention of finding grossly or microscopically, any inclusion cysts or cyst walls within the bony parts. We have had the opportunity to carry out Weeder's suggestion in only 1 case since his article was published (case described under "Pathology"). Sections through all the coccygeal joints revealed normal bone and joint structures. There was no evidence of inflammation or tumor or cyst inclusion. However, scattered along the sides of the coccyx were seen minute round vascular bodies like paraganglia consisting of polyhedral cells with densely staining nuclei surrounding blood spaces. These, of course, should not be confused with neural rests the epithelium of which is cuboidal or cylindrical and occasionally ciliated. Grossly there was no evidence of invasion of the sinus tracts into the bony parts. Undoubtedly the discoloration of the joint, or of periosteal or ligamentous structures, when found is due to the trauma of a previous operation or damage by bacterial or chemical agents. Also if Weeder's theory were true a large percentage of the primary and all the recurrent cases should never have been cured.

However, in this connection it should be stated that occasionally the sinus tract leads down to the coccyx (as was shown in Figure 6). In these instances the coccyx should be thoroughly trimmed of its periosteal and fibrous covering. If the deeper structures are involved especially in recurrent cases in which a periosteal reaction may have been already set up, it may be safe and wise to

¹ Personal communication.

excise the coccyx. However the danger of a low grade osteomyelitis complicating such a procedure was pointed out by Stone¹ following his case previously described. For this reason and also because in many cases the sinus is very superficial and may be limited to the level of the sacrum it is felt that removal of the coccyx except in a few instances is not indicated.

A REVISED CLASSIFICATION OF CONGENITAL SACROCOCCYGEAL TUMORS

It is apparent that a different classification of tumors must be made on the basis of the embryological and histogenic character of the structures found in this region (Table I)

TABLE I—SACROCOCCYGEAL NEOPLASMS

	Tissue	Structure	Tumor
A.	Ectoderm	Epidermis	Pilonidal sinus, dermoid cyst
B.	Neuroectoderm	Medullary vestiges Meninges	Solid neoplasms— epithelioma, cy- to-adenocarcinoma Meningioma
C.	Ectoderm	Postanal pit	Keratinous cyst, an- terior cyst, dermoid cyst, carcinoma
D.	Mesenchyme	Notochord	Chordoma
E.	Undifferentiated tissue A-B-C-D	Tail vestiges	Teratomas

1 *Pilonidal cysts* The pilonidal cyst is a congenital lesion due to a process of normal ectodermal invagination in the embryo which usually disappears but in these cases has persisted in adult life. It commonly contains fine, silky light colored hair and mucoid or gelatinous material is almost always infected and its walls consist of several layers of epithelial cells with glands and hair follicles. Derived from budding or growth centers in the basal layer of the ectoderm which give rise to hair follicles and glands, it consists of cells which form only hair and glandular appendages. For this reason one never sees teratomata, neurogenic growths, or heterologous tumors in pilonidal sinuses. The lesion becomes evident after the middle of the second decade and is probably associated with the development of secondary sex changes concomitant with puberty.

Perianal communication.

2 *Coccygeal medullary restiges* F B Mallory (26) reported a glioma originating in the subcutaneous tissues over the coccyx, in a female age 44 years, which metastasized to both groins. Histologically it consisted of small alveoli lined with epithelial cells embedded in a fairly abundant connective tissue stroma. Mallory by differential stain demonstrated coarse, wavy fibrils between cells which filled the alveoli which were unlike connective tissue or smooth muscle fibrils. The tumor in the lymph nodes showed a papillary structure. Undoubtedly this was a neuro-epithelioma, and probably arose from the neural rests which he and Herrmann and Tourneux described. Mallory believed that it had the same origin as the pilonidal sinus.

Fowler described a huge cyst over the sacrum of a 2 months old female associated with bony defects of the sacrum and coccyx. The cyst repeatedly refilled following aspiration. Operation revealed no communication with the spinal canal but this might have easily been missed. The cyst was lined with ciliated cylindrical epithelial cells and was multilocular in character. The tumor was probably derived from a medullary rest of the primitive neural tube its lining being similar to that of the neural canal in early embryonic life. Tumors of this type have no connection with pilonidal cysts.

Law in reviewing the literature on pelvic tumors with sacral attachment, found only 30 cases and added a case of his own—a neuroblastoma in a female, age 27 years.

The coccygeal medullary vestiges may thus in rare instances give rise to large multilocular cystic or solid growths usually on the posterior surface of the sacrum and coccyx (Fig 10). They may present anteriorly if the tumor is large or has invaded the pelvis. The large cystic masses nearly always occur in the newly born or young infant.

3 *Herniation of the cul-de sac of the terminal meninges* Meningocele presents very little diagnostic difficulty but the association of pilonidal sinus in cases of spina bifida complicated by meningitis has been used by certain writers to support the neurogenic theory.

Ripley and Thompson reported a case of pilonidal sinus with spina bifida in a 3½

months old infant. The patient developed meningitis and died. Examination revealed a sacrococcygeal dermoid. The writers believed that the sinus arose from the vestiges of the neural tube. Moise reported a case of a male 18 years of age who was admitted to the New Haven Hospital with headache and pain in the back. He had always had a sinus in the lower lumbar region of the back associated with an intermittent discharge of water fluid. Examination revealed a *Staphylococcus albus* meningitis with spina bifida occulta. Sacral laminectomy was done and effective drainage instituted. The patient survived and was discharged living and well. The author claims that the discharge was probably cerebrospinal fluid and that the sinus led into the dura but his evidence is circumstantial and inconclusive. The meningitis can easily be explained by the lack of bony protection and by either the direct, lymphatic or metastatic extension of the infection particularly in cases of cystic spina bifida where the expanded subarachnoid space lies close to the skin (18). Moore has even reported a proved case of pilonidal sinus containing cerebrospinal fluid, one in which the sinus showed a direct communication with the spinal canal.

4 *Postanal gut and neurenteric canal* Certain anococcygeal tumors and cysts are said to arise from the remnants of the postanal gut and the neurenteric canal. In the early embryo the central canal of the spinal cord and the alimentary canal are continuous around the caudal extremity of the notochord (4). By this union is formed the neurenteric canal which subsequently atrophies and forms a fibrous cord. Hansmann and Ewing cite several cases of tumors containing intestinal wall and portions of nervous tissue which arose from these rests.

The postanal gut is formed as the result of the union of the invaginating portion of the proctodeum, or primitive anus with the intestine at a point anterior to the neurenteric canal. Thus a segment of intestine is left behind which atrophies and disappears. Occasionally in the newly born or young infants a vestigial structure remains which gives rise to cystic tumors situated anterior to the sacrum or coccyx. These tumors were formerly called

"congenital cystic sarcoma." They are composed of closed vesicles lined with glandular epithelium and containropy mucus, or glue like fluid (4). The epithelium consists of columnar and goblet cells and one of the essential features for diagnosis is that the cysts have no serous or muscle coats (32). Middeldorp¹ is said to have been the first to recognize a tumor of this character. Ballantyne reviewed the literature on these tumors and added a case of carcinoma of postanal intestine in a female, aged 38 years. He found only 4 other cases reported. Huge dermoids and teratoma attached to the rectum or sacrum have been described (11, Fig 11, 4, 17, 27).

Tumors of this group are usually single and always occur anterior to the coccyx and sacrum, may be confused with neurogenic growths, but have nothing in common with pilonidal cysts.

5 *Coccygeal gland* The coccygeal gland was originally described by Luschka in 1860. It was first thought to be a single body in front of the apex of the coccyx about 2.5 centimeters in size. In Quain's *Anatomy* the following histological description is given. It consists of masses irregular in shape and size which are very vascular, the vessels having a sinusoidal character. The cells of the gland come into close relationship to the anuses with only a layer of endothelium between, indeed, the presence of this layer is not always easy of detection. Numerous nerves pass to the coccygeal gland and Luschka described ganglion cells within it, but this description has not been confirmed by modern investigation. Jacobson² believes that the mode of development and function of the coccygeal gland are probably connected with that of the sympathetic nervous system.

However (as was shown in Dr Stone's case) the coccygeal gland is only one of a number of paraganglia which are present in this region and which may give rise to paraganglionic tumors. J Crawford Burns described a case of what he thought was a coccygeal body tumor. It was in a male, 22 years who had a hard fixed mass in the sacrum the size of a fetal head and unattached to the rectum. The

¹ Arch. f. path. Anat., etc., 101: 37

² Arch. f. mikr. Anat., 1899, vol. 52.

specimen which was removed at operation consisted histologically of polyhedral cells and numerous blood vessels. The cells were arranged in masses of irregular columns of a malignant nature. The growth subsequently recurred with large pelvic masses and was inoperable. Of course, one should not confuse these tumors which rarely metastasize with sacrococcygeal neuro-epithelioma which are of high malignancy. On the other hand coccygeal paraganglioma should not be ruled out, as has been done (2) on account of finding a normal so called Luschka's gland because

Luschka's gland may be represented by a number of paraganglia in the coccygeal region, a fact which is not generally recognized.

6 *Chordoma*. These tumors are mentioned merely because they occur in the sacrococcygeal region and may be confused with the other groups. Their structure resembles hyaline cartilage and mucin may be present. They may grow in an alveolar fashion and must be differentiated from myxochondroma and colloid carcinoma of the intestinal canal (Ewing—Fig. 12). Fried and Stone described a case of chordoma which was treated for 9 years for a fistula in ano, perirectal abscess, etc., and the true condition was not discovered until the case came under their observation and microscopic section had been made (Rankin, Barger and Buie).

SUMMARY AND CONCLUSION

Evidence is presented from studies on the human embryo which indicate

1 That pilonidal sinus is a derivative of skin ectoderm and not neurogenic or enteric in origin.

2 That the structures forming the sinus are derived by a process of ectodermal invagination from the skin surface at the time and in the cells destined to form skin appendages (hair and glands) during the third and fourth months of embryonic life.

3 That its mode of origin and the analogy drawn between this structure and the special 'scent' gland in the sacrococcygeal region of birds and amniotes suggest the probability that the sinus represents a vestigial skin appendage developing at puberty—hence the age distribution of pilonidal sinuses.

4 That coccygeal medullary vestiges exist is not denied but they do not give rise to the pilonidal sinus. They probably give rise to the large cystic and solid tumors which occur usually in infants and the newly born. There is also the possibility that they may play a rôle in the upward direction which the pilonidal sinus takes.

5 Clinical and pathological findings are presented which are satisfactorily explained by this theory.

6 Other congenital growths of the sacrococcygeal region are described because of the sinuses and fistulae which these structures have produced—to clarify some of the confusion which has surrounded the history of their development. In this connection it is suggested that the coccygeal region may possess several sites for the origin of paraganglioma instead of only Luschka's gland as originally thought.

7 It is felt that recurrence following operation for pilonidal sinuses should take place in less than 10 per cent of the cases and is due to the fact that certain of the ramifications are left behind. Furthermore since the coccyx is fully developed in the first 6 weeks of fetal life and has no dorsal arches, and since the fourth and fifth sacral vertebrae have only vestiges of the neural arch it is quite illogical to assume that the coccygeal medullary vestiges may be included within the sacrococcygeal joint. It is my belief that in operations for pilonidal sinus wherein the coccyx is removed and the sacral stump curetted the improvement which is described is not due to the excision of included coccygeal medullary vestiges but due to the removal of the contiguous infection of periosteal or bony parts. One case is reported in which such an operation has been performed and in which no pathological changes could be demonstrated. Low grade osteomyelitis complicating such a procedure should be borne in mind.

8 In the prevention of recurrences it is suggested that wherever the sinus tract extends to the bony parts, the periosteal and fibrous layers should be carefully stripped off and curetted. Dead spaces and recesses with inflammatory products should be guarded against by preventing too early epithelial bridging of the wound and by careful packing.

BIBLIOGRAPHY

1. BALLANTYNE, E. M. Arch. Path. 1932, 14, 1
2. BATEMAN, E. J. Ann. Surg. 1924, 80, 834.
3. BEAVER, C. New England J. Med., 1930, 303, 750.
4. BLAND-SUTTON Tumors—Innocent and Malignant. 1903 3d ed 367-369.
5. BOOKMAN, M. R. New York State J. Med. 1924, 24, 301.
6. BURNS, J. C. Report of tumor of coccygeal gland, Edinburgh M. J., 1916 17, 160.
7. CATTILL, R. B. and STOLLER, L. W. New England J. Med. 1932, 306, 110-113.
8. COLE, R. The treatment of pilonidal cysts and fistulae. Surg. Clin. N. America, 1929, 9, 695.
9. COURAUD, J. (Quoted by Stone) Contribution à l'étude des dépressions, fistules, etc., de la région sacrococcygienne. Paris, 1883.
10. DULLIGAN, P. J. Pilonidal cyst. Am. J. Surg., 1920, 6, 554.
11. EWING, J. Neoplastic Diseases, 1928, 3d ed., 211, 1633, 1639.
12. FOWLER, G. R. Congenital sacro-coccygeal cyst. Ann. Surg. 1885, 1, 115.
13. FRIED, H. and STONE, H. B. Four rare rectal tumors. Surg. Gynec. & Obst., 1930, 50, 762-768.
14. GROSS. Quoted by Mallory.
15. HAREMANN, G. H. A congenital tumor of the neur enteric canal. Surg., Gynec. & Obst., 1926, 42, 124.
16. HODGES (Quoted by Stone) Boston Med. & Surg. J., 1880, 103, 485, 493, 544.
17. HURKE, F. Congenital sacro-coccygeal cyst. Arch. Pediat. 1892, 9, 891.
18. KETKE, A. Human Embryology and Morphology 1921 4th ed 85.
19. LANEY FRANK H. Surg. Gynec. & Obst. 1932, 54, 521.
20. LANDRMAN A. A. Principles underlying the surgical treatment of certain infections about the sacro-coccygeal region. Med. Rec. 1918, 94, 980.
21. LAW, A. A. Surg., Gynec. & Obst. 1922, 35, 593.
22. LEWIS, D. Lewis System of Surgery 7 Chap 6 42.
23. LUMORHETTL (Quoted by Stone) Arch. f. mikr. Anat., 1907, 69, 264.
24. LUSCHKA, H. Arch. f. path. Anat., 1860, 18, 106.
25. MALLORY F. B. Ann. J. M. Sc., 1892, 103, 269.
26. Idem. J. Med. Research, 1904, 1905, 131, 113.
27. MARSON J. C. Surg. Clin. N. America, 1925, June, 727.
28. MOORE, T. S. Surg., Gynec. & Obst., 1926, 42, 304.
29. NELSON Nelson's System of Surgery 5 Chap 111, 187.
30. OESHLACHER, F. Sacral abscesses in congenital skin displacements. Deutsche Ztschr. f. Chir., 1926, 197, 262.
31. PARIS. (Quoted by Stone.) Arch. de zool. exper. et gen., 1913, 1914, 53, 139.
32. PETERON A. Bull. de l'ass. franç. p. l'étude du cancer, 1918, 17, 613, Cancer Rev. 1930, 5, 129.
33. QUAIN Quain's Anatomy 1912, 2 Pt. 1, 688.
34. RABOW BARON, and BUTE. Colon, Rectum and Anus, p. 407 Philadelphia W. B. Saunders Co., 1932.
35. RIPLEY W., and THOMPSON D. C. Pilonidal sinus as route of infection in a case of staphylococcus meningitis. Am. J. Dis. Child., 1928, 36, 785.
36. SCHUMACHER. (Quoted by Stone.) Anat. Anz. 1910, 52, 291.
37. STONE, H. B. Pilonidal sinus. Ann. Surg. 1924, 79, 410.
38. Idem. Ann. Surg. 1931, 94, 517.
39. STEINER, G. L. Am. J. Anat. 1919, 35, 1.
40. TONNOKUX, F., and HERRMANN G. J. de l'anat. et physiol., 1887, 23, 488.
41. VAUGHAN Quoted by Mallory.
42. WARREN J. M. Surgical Observations, p. 192 Boston, 1867.
43. WEEKER, S. D. Pilonidal cyst. Ann. Surg., 1933, 98, 385.
44. WEINSTEIN M. Pilonidal sinus. Ann. Surg., 1935, 97, 80.
45. WUNDERLICH, H. (Quoted by Ewing and Stone.) Ueber Hautentstulpungen und haarhaltige Fisteln in der sacrococcygeal Gegend. Bonn, 1885.

FUNCTION OF THE LONG PLANTAR MUSCLES

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THOUGH 'the foot functions as a whole and the interactions of the several muscles form a complete unit which must be studied in its entirety' as stated by Hallisy accident and disease tend to concentrate on individual muscles, and to correct the ill effects of these agents intelligently the clinician must have an understanding of the manner in which individual muscles function. Medical literature yields very little exact information concerning the function of those muscles commonly referred to as the long plantar muscles. This dearth of detail is apparently due to the tendency of medical writers to consider the foot as the movable terminus of a fixed leg rather than in its more important function as a fixed base for support and propulsion of the body as a whole.

For example standard textbooks, such as those of Gray, Cunningham, Pierson and Spalteholz give the function of the tibialis posterior as extension, inversion and adduction of the foot. Special studies of the motor system by Lovett, Wright, Mackenzie and others go little if any further into the subject. In German literature one finds a large amount of detailed and exhaustive investigation particularly in respect to muscle weight, cross section area, volume etc. with considerable attention paid to these muscles in their relation to flat foot, but again adequate practical discussion is lacking.

Schlepe, in discussing flat foot due to traumatic section of the tibialis posterior tendon attributes a primary rôle in sustaining the arch of the foot to this muscle. He finds that Hoffa, Schults, Franke, and Frank support this contention but that Lorenz and others deny it. That Nicolodoni finds this muscle important but not fundamental while Biesalski, Flick, and Mayer ascribe the same function and nearly equal importance in preservation of the arch, to this muscle and the flexor digitorum longus.

Meng, basing his argument on Weber's evaluation of muscle work from its mass, found by

cross sections of the long plantar muscles that in flat feet the flexor hallucis longus is one third weaker than in normal feet though the other muscles are practically unchanged. He regarded the flattening of the arch as the result of the weakness of this muscle and treated the deformity by shortening its tendon. Since a stretched muscle undergoes atrophy it is possible that Meng has confused cause and effect.

A muscle functions by contracting in length to approximate its points of origin and insertion. Either end may act as a fixed point toward which the other is drawn, or in regard to which it is stabilized. In general, muscle pull is exerted in a straight line between two points of attachment. In the muscles under discussion direction of force is changed approximately 90 degrees by arrangement of bones and ligaments comparable to pulleys. Force is then exerted not only at the origin and insertion of the muscle but upon the pulley which tends to move according to the law of component and resultant forces.

The origins and insertions of the long plantar muscles have been sufficiently described by many anatomists. The relation of their tendons to the pulleys, and the rôles of the pulleys themselves in maintaining foot posture have been largely ignored. The present purpose is a review of these details in relation to the preservation of foot posture.

The tibialis posterior has a large origin from the upper central area of the back of the leg. Its principal insertion is into the medial and plantar aspects of the navicular tubercle. Other strong fasciculi are inserted into the medioplantar portions of the metatarsal bases and into the tarsal bones anterior to the calcaneus and talus. Its tendon grooves the back of the medial malleolus and, under the tough ligamentum laciniatum, is separated from the medial surface of the neck of the talus by a thick fibrous pad. Its strongest insertion is into the tubercle of the navicular below and medial to the talonavicular joint.

Other fasciculi extend under the head of the talus to the anterolateral tarsal area. Contraction of this muscle approximates the navicular tubercle to the medial malleolus, inverting and plantarflexing the anterior segments of the tarsus on the posterior. When the ball of the foot is fixed in weight bearing, the same force lifts the head of the talus upward and outward, at the same time forcing the malleolus forward. The arch sustaining power of the tibialis posterior is exerted primarily on the medial malleolus and navicular. The navicular rotates about an axis in the neck of the talus. The same force that inverts the navicular by traction on its tubercle will, when this bone is the more firmly fixed, evert the head of the talus, a motion abetted by forward movement of the internal malleolus (Fig 1).

The writer is at loss for a term to describe accurately the motion occurring in the talonavicular and calcaneocuboid articulations. Together these joints comprise the transverse tarsal articulation. The talonavicular is a shallow ball and socket joint allowing motion in all directions but its mobility is greatly restricted by the almost fixed calcaneocuboid relation. In this discussion the term inversion is used to denote that combination of medial motion of the foot with adduction of the anterior tarsus and rotation upward and outward of the talus head at the talonavicular joint.

The flexor digitorum longus arises from the middle three-fifths of the inner portion of the back of the tibia and is inserted into the four outer toes. Its tendon crosses the articular line of the tibia lateral to the base of the malleolus and makes its turn in a strong ligamentous tunnel on the inner surface of the talus behind below and lateral to the tibialis posterior. It lies medial to the sustentaculum tali, passes under the outer half of the talonavicular articulation and beneath the joint between the second and third cuneiforms. In the sole it receives a reinforcement from the flexor hallucis longus which crosses above it. Its function is given as flexion of the toes, plantar flexion and inversion of the foot. With the ball of the foot fixed in weight bearing, it lifts the talus and adjacent tarsal bones upward and forward. Because its tunnel is

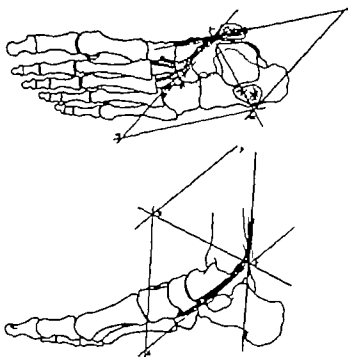


Fig. 1 In this and the following illustrations made from tracings of X rays of the foot in medial, lateral, and dorso-plantar views, with the tendons marked by wires, T marks the turn of the tendon about a pulley. The lines AT and PT represent equal forces anterior and posterior to the pulley and RT the resultant force exerted on the pulley. The force actually applied to the pulley is a combination of the forces shown in the two views. It cannot be accurately represented in a two dimension figure. The tibialis posterior. When the foot is fixed in weight bearing this tendon forces the inner malleolus forward, and lifts the head of the talus upward and outward. Loss of its support allows the malleolus to move backward the talus and navicular to rotate downward and inward, and the foot to evert, particularly at the talonavicular joint.

medial to the subtalar talocalcaneal articulations and its tendon extends laterally to the outer toes, it also forces the talus outward on the calcaneus. Its power is expended primarily on the talus (Fig 2).

The flexor hallucis longus arises from the lower and outer portion of the back of the leg and is inserted into the base of the terminal phalanx of the great toe. Its tendon, well away from the malleolus, traverses the groove on the posterior margin of the talus and is bound tightly in a fibrous tunnel on the medial surface of the calcaneus a half inch behind and lateral to the flexor digitorum. It runs under the sustentaculum tali, crosses above the flexor digitorum longus to which it gives a slip and extends under the first metatarsal parallel to the inner border of the foot. Its

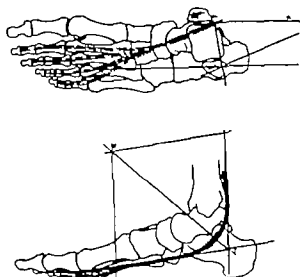


Fig. 2 The flexor digitorum longus exerts an upward and outward lift on the talus and calcaneus. Loss of its function allows the foot to evert at the subtalar articulations and the longitudinal arch to sag.

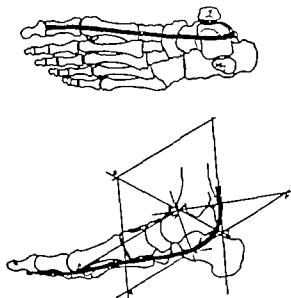


Fig. 3 The flexor hallucis longus, when the ball of the foot is fixed, forces the talus forward and upward, and lifts the anterior part of the calcaneus upward. The tendon turns first in a notch on the posterior margin of the talus, then under the sustentaculum tali. Loss of its support allows depression of the midtarsus, and eversion at the talocalcaneal joints.

function is given as flexion of the great toe and plantar flexion of the ankle joint. In weight bearing its contraction lifts the anterior part of the calcaneus upward forward and outward elevating the arch and inverting the foot. Its arch elevating power is exerted on the calcaneus (Fig. 3).

The peroneus longus arises in the outer and upper part of the back of the leg and is inserted into the first cuneiform and the base of the first metatarsal. Its tendon turns behind the lateral malleolus, crosses the lateral surface of the calcaneus and base of the cuboid and extends diagonally across the sole under the cuboid and two outer cuneiforms. Under the cuboid it lies in a deep tunnel formed by the tuberosity of that bone and strong ligaments. Its function is commonly given as eversion and plantar flexion of the foot. With the foot fixed it presses the lateral malleolus forward and lifts the cuboid upward, inward and, by relation of its tendon to the anterior surface of the tuberosity backward thus supporting the outer border of the arch and with the cross insertion of the tibialis posterior consolidating the transverse tarsal arch (Fig. 4).

The peroneus brevis extends from the outer and lower leg area to the base of the fifth

metatarsal. Its tendon is in direct relation to the lateral malleolus and, particularly when the foot is inverted, makes contact with the calcaneus and cuboid. Its contraction approximates the lateral malleolus and the fifth metatarsal base. It is not actually a plantar muscle, and has little function in weight bearing except in stabilizing the leg laterally. With the metatarsal fixed this tendon exerts a definite forward and lateral force on the fibular malleolus (Fig. 5).

To compare the rôles of these several muscles in actual weight bearing with the foregoing conclusions drawn from a study of their physical relationships a simple apparatus which may be described as follows was arranged. An ordinary bathroom scale was set upon a base board. A foot and leg from which all soft tissues except the long muscles and the ligaments had been removed was set upright on the scale. A small wooden block was placed on the upper end of the tibia, and on this another block with a nut on its under surface through which a bolt was screwed to impinge on the first block. The upper block was attached with wires to the base board. By

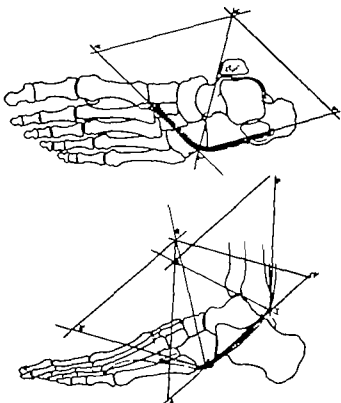


Fig. 4. The peroneus longus turns first behind the outer malleolus, which it forces forward, then about the cuboid which it lifts upward, inward and slightly backward. Loss of its function lowers the outer border of the foot and allows the foot to invert easily.

screwing the bolt down any desired pressure was registered on the scale. Strong sutures were placed in the tendons of each muscle and other sutures in the muscles near their origins. Muscle tissue between the two sets of sutures was replaced by elastic bands tension upon which was easily varied by adjusting the suture ties (Fig. 6).

It was found that in dissecting room material the arches of the foot could not be completely depressed without application of force sufficient to rupture the hardened structures. Therefore the plantar ligaments between each two bones were cut relegating support of the arches to the long muscles alone. In this condition the weight of the leg was enough to flatten the arches.

Since little is known as to the actual force exerted by individual muscles in preserving normal foot posture an arbitrary amount of 5 pounds was applied to each of the muscles under discussion. It was applied by interposing stretched rubber bands between the tendons and bellies of the muscles. By test

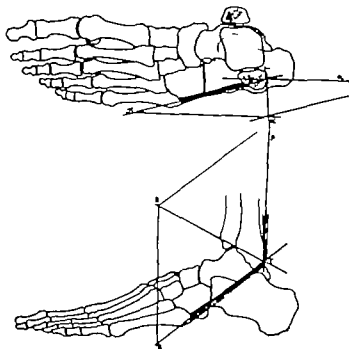


Fig. 5. The peroneus brevis is primarily a lateral stabilizer of the foot. It exerts a forward and lateral force on the outer malleolus and elevates the base of the fifth metatarsal.

with a spring balance it was found that the rubber bands used were of constant elasticity, and that when 5 pounds traction was applied to any doubled band the band attained a length of 3 inches. Pulls were then exerted on the individual tendons by tightening the anchoring sutures until the interposed doubled bands were stretched to that length.

Experiment 1 An elastic pull of 5 pounds each was applied to the tendons of the tibialis posterior, flexor digitorum longus, flexor hallucis longus, and the peronei longus and brevis. These produced plantar flexion of such an extent that weight bearing pressure could not be applied through the tibia to the foot. Similar pulls were therefore applied to the tibialis anterior and the extensor longus digitorum. These held the leg at a right angle with the foot. The limb was then arranged in the apparatus as described, and subjected to weight bearing stress by screwing down the adjusting bolt. As pressure was increased the talonavicular and calcaneocuboid articulations gave way. The latter was completely depressed to the scale floor at 17 pounds, the former at 55. When pressure was again reduced the arches were restored.

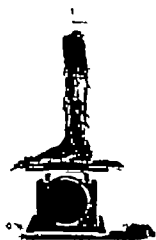


Fig. 6 Photograph of the apparatus used in Experiments 1 and 2, showing a leg and foot under adjustable weight bearing pressure. All plantar structures, except the tendons under discussion, have been removed, and all ligaments cut. The arch is sustained by the rubber bands which replace the muscle bellies, under pressure of 40 pounds.

Rotation of the leg forward on the ankle joint elongated the posterior bands while those of the anterior muscle group shortened. The added stress on the anterior portion of the arch from forward shifting of the weight was thus compensated by increased tension on the posterior tendons. In backward rotation of the leg the anterior bands stretched and the posterior shortened. Tonus of these rubber muscles thus adjusted itself to the varying stresses consequent upon the changing positions of weight bearing.

There is, of course, no reason to assume that the different muscles exert an equal force in preserving foot posture. The great amount of work done in determining cross section volume mass and unit work values of muscles is of little practical importance as each of these muscles works under a different arrangement of pulleys and levers, so that a weaker muscle may actually accomplish more than a stronger one. Until the factor of leverages is added to the existing complicated tables of weights and measures the functional value of an individual muscle cannot be determined. The writer lacks the mathematical ability to estimate

these factors and questions the practical benefit to be derived, were he able to do so. The present effort is not concerned with determining the actual force exerted by the individual muscles, but with demonstrating first the particular rôle of each muscle and second its relative importance in maintaining foot posture.

Experiment 2 One at a time the individual muscles were freed, tension being maintained upon the others.

With the *tibialis anterior* free the cuboid touched the scale at 13 pounds the navicular at 48. The force of this muscle is exerted in a direct upward pull on the inner border of the longitudinal arch. Its efficiency is in direct ratio to its pull.

When the *tibialis posterior* was released the outer border of the foot reached the scale under 8 pounds pressure. With increasing weight the medial malleolus shifted backward the head of the talus downward and the navicular was completely depressed when the scale registered 40 pounds. These combined movements resulted in a caving inward and downward of the mid tarsus. The weakening of the foot resulting from release of the *tibialis posterior* tendon was out of proportion to the 5 pound pull involved. The increase in force of this muscle is accomplished through the action of a virtual lever arm arrangement in the talonavicular articulation. The navicular glides about the head of the talus like a segment on the surface of a sphere. Its center of motion lies in the neck of the talus. The length of its lever arm is the radius of the sphere, that is, the distance from the center of motion to the tubercle of the navicular where the tendon of the *tibialis* is attached. When the navicular becomes the more firmly fixed the head of the talus glides upon it in a reverse direction.

With the *flexor digitorum longus* released the cuboid reached the scale floor at 10 pounds pressure the navicular at 44 pounds. The malleolus advanced but little more of the movement being accomplished by the talus.

Freeing of the *flexor longus hallucis* let the outer border of the foot down at 13 pounds, the inner border at 40 demonstrating a slightly weaker support of the lateral border

of the foot by this muscle than by the flexor digitorum longus, but a stronger support of the medial border. Weakening of the foot from loss of the flexor hallucis longus was particularly noticeable in the subtalar articulation. The talus and navicular maintained their interrelation more closely than after loss of other muscles but both rotated medially and downward along with the anterior end of the calcaneus to produce the simple eversion type of flat foot without pronounced mid tarsal deformity.

The positions of the tendons of these last two muscles medial to the center of motion in the subtalar talocalcaneal joints give them a moderate mechanical advantage so that their actual pulls are increased somewhat in effect.

Release of the peronei had no effect on the inner border of the foot. The outer border was depressed in each instance under 15 pounds.

This experiment demonstrated two means of support of the longitudinal arch, direct upward pull as exhibited by the tibialis anterior and peroneus brevis in which work accomplished is in direct relation to the force applied, and second, lift from below as shown by the long plantar muscles, which is increased in effect by mechanical advantages of pulleys and levers.

Experiment 3 The leg being held stationary in a vertical position the foot free and all other muscles free 5 pounds pull was applied to each muscle in turn.

The tibialis anterior elevated the inner border of the foot, then dorsiflexed the foot.

The tibialis posterior adducted and plantar flexed the anterior part of the foot on the posterior, then inverted and plantarflexed the foot as a whole.

The flexor digitorum longus, in addition to flexing the four outer toes, inverted and plantarflexed the foot, considerably increasing the arch by plantarflexing the fore part of the foot at the mid tarsal joint.

The flexor hallucis longus inverted the foot less than the flexor digitorum, but plantar flexed it and elevated the arch by the same action at the mid tarsal joint.

The peroneus brevis raised the outer border of the foot then everted and plantarflexed the

TABLE I—RELATIVE EFFICIENCY OF THE DIFFERENT MUSCLES IN MAINTAINING FOOT POSTURE

	Pounds pressure required to depress	
	Talocranule	Calcaneocuboid
With 5 pounds pull on each muscle	55	7
With tibialis anterior free	48	13
With flexor digitorum longus free	44	10
With flexor hallucis longus free	40	13
With tibialis posterior free	40	8
With peroneus longus free	55	5
With peroneus brevis free	55	15

foot as a whole. The peroneus longus did the same with more efficiency.

This experiment demonstrated the usual textbook actions of these muscles. In a study of the foot's major functions of weight bearing and propulsion they are of minor importance.

DEDUCTIONS FROM STUDY

In studies of flat feet it is recognized that the long plantar muscles play leading roles in maintaining the longitudinal arch that the tibialis posterior and peroneus longus through their cross insertions are also active in preserving the transverse tarsal arch that the tibialis anterior is primarily a dorsiflexor and that the peroneus brevis functions primarily in stabilizing the leg on the foot laterally.

The tibialis anterior supports the fore part of the longitudinal arch. The importance of this forward support is demonstrated in those instances of metatarsus varus described by Peabody and others, in which there is anomalous insertion of this tendon at the metatarsophalangeal joint. Hallus in his study of the foot muscles has recorded this as one of the more common variations in insertion of the tibialis anterior. In this condition the anterior tarsus sags laterally while the metatarsophalangeal area is held inward by the anomalous tibialis anterior and the hypertrophied adductor hallucis. Growth of the metatarsals under these abnormal stresses leads to distortion of their shafts. The writer treats this deformity by transplanting the anomalous tibialis to its usual insertion, and

freeing the adductor hallucis from its origin on the calcaneus by Steindler's method. With the faulty stress removed the bones straighten themselves without surgical mutilation.

The tibialis posterior functions in maintaining the malleolotalonavicular relationship in horizontal, vertical and sagittal planes. It is the only muscle acting directly on these parts, and the only one that forces the medial malleolus forward. Its loss allows eversion and depression at the mid-tarsal joint.

The flexor digitorum longus supports the arch by holding the talus upward forward and outward in relation to the metatarsus and the heel. Loss of its support permits depression of the talus and inward rotation of this bone on the calcaneus, the simple type of everted flat foot.

The flexor hallucis longus maintains the arch by elevation and forward lift on the sustentaculum tali of the calcaneus. Its effect is similar to that of the flexor digitorum longus. Though it lacks the latter's lateral insertion it derives from its more medial position a greater power in lifting the inner border of the mid tarsus. Its loss results in the same type of deformity as loss of the flexor digitorum.

The peroneus longus supports the outer border of the foot consolidates the anterior

tarsus and stabilizes the foot and leg laterally. Its loss results in depression of the transverse arch and a tendency for the ankle to turn outward in weight bearing.

CONCLUSIONS

Each of the long plantar muscles plays a specific part in maintaining normal foot posture. Their individual rôles depend more upon their relations to bone and ligament pulleys about the ankle than on their points of origin and insertion. Efforts to preserve or restore the arch must be based more than is ordinarily the custom on the particular need of the individual patient as determined by careful analysis of his disability.

REFERENCES

1. HALLIS, JAMES E. C. The muscular variations in the human foot, muscles of the inner border of the foot and the dorsum of the great toe. *Am. J. Anat.*, 1930, 45: 4: 1-442.
2. MIELO, HEINRICH. Die Rolle der tiefen Unterschenkelmuskeln in der Pathogenese, Prophylaxe, und Therapie des Plattfußes unter besonderer Berücksichtigung des Musculus flexor Hallucis longus. *Ztschr. f. Orthop. Chir.* 1930, 20: 454.
3. PEARSON, C. W. Congenital metatarsus varus. *J. Bone & Joint Surg.* 1933, 15: 171.
4. SCHLIEFF, ARNOLD. Traumatische Durchtrennung des Tibialis posterior und Plattfuß. *Ztschr. f. orthop. Chir.* 1929, 50: 53.

THE BLOOD SEDIMENTATION TEST AND ITS VALUE IN THE DIFFERENTIAL DIAGNOSIS OF ACUTE APPENDICITIS¹

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VARIOUS theories for the explanation of the phenomenon of blood sedimentation have been advanced, but the one which is almost universally accepted after considerable experimental investigation is that advanced by Fahraeus, whose work gave renewed interest to a neglected subject. His opinion was that the determining factor in the sedimentation reaction is the seroglobulin and fibrinogen, both of which substances are present in the blood plasma in increasing quantities in the diseased states. This opinion has been recently confirmed by Gilligan and Ernste. Other factors such as the adsorbability of the erythrocytes and carbon dioxide tension of the blood are also mentioned but were shown to be of only secondary importance.

TECHNIQUE

The original Westergren technique was first applied in our study of cases. This procedure was as follows: 4/10 of a cubic centimeter of 3.8 solution of sodium citrate was drawn up into a 2 cubic centimeter syringe, with this same syringe, blood was then taken from a vein to make a total of 2 cubic centimeters. After placing this blood in a test tube and shaking the citrated blood was drawn into a glass tube 2 millimeters in diameter to make a column 200 millimeters in height. This glass tube was placed in a rack and readings of the level of sedimentation of the blood were taken every 10 minutes up to the final hour reading. In doing a large number of cases routinely on admission it was found necessary to modify this technique for purposes of simplicity and speed.

Our modification allowing accurate Westergren interpretation was devised as follows: Test tubes are prepared each containing 30 milligrams of dried sodium citrate; these tubes are kept available in the wards at all times. To perform the test, 4½ cubic centimeters of blood are drawn from a vein, added to a test tube and shaken thoroughly, the test then pro-

ceeds as in the original method. However, readings were taken at the end of 15 minutes and at the end of the hour, the final hour reading being the one referred to in all discussion of the sedimentation rate. In order to simplify the discussion of the various readings of the blood sedimentation reaction in the varied groups of cases, we have divided the gradation of readings as follows:

6 millimeters to 15 millimeters in the hour—normal reaction
15 millimeters to 40 millimeters in the hour—moderate reaction
60 millimeters to 80 millimeters in the hour—high reaction
80 millimeters to 140 millimeters in the hour—severe reaction

CLINICAL CASE GROUPS

In the latter part of 1931, we began to study the blood sedimentation rate in various types of cases in the wards at the Metropolitan Hospital. Our initial interest was to observe the relationship of this sedimentation reaction to the leucocytic response of the blood. These cases finally divided themselves into several large groups on a clinical basis. Two thousand cases both medical and surgical were studied, aligning themselves into the following groups:

1. Pneumonia and complications
2. Tuberculosis
3. Rheumatic fever
4. Pregnancy and complications
5. Acute and chronic salpingitis (adnexal disease)
6. The acute surgical abdomen, with stress on differential diagnosis of conditions in the right lower quadrant

1. *Pneumonia and complications* In general, the study of 60 cases, with an average of 5 weekly readings in each case, revealed a definite index to prognosis in the course of the disease. The acute, full blown case, regardless of type, showed an average reading of 80 to 100 millimeters in the hour and with beginning resolution and convalescence the study of cases showed a gradual decrease in the sedimentation reading. With the onset of

complications, such as pleurisy, empyema, or pericarditis, a sudden sharp increase in sedimentation rate was noted.

2 Tuberculosis. In pulmonary tuberculosis, we have found that the height of the sedimentation reading is an accurate indication of the extent and activity of the pulmonary pathology. Similarly in tuberculous peritonitis, high sedimentation readings were obtained. Fifty cases were studied, our interest being chiefly in allocating various types and degrees of pulmonary pathology in our sedimentation classification. Repeated readings were not done, and indications as to prognosis and treatment were not investigated. Hilary Roche recently contributed an excellent paper on the blood sedimentation with particular reference to its relationship in the course and management of the condition.

3 Rheumatic fever. Forty cases were studied at regular intervals averaging five readings to the case. During the acute clinical phase of the disease the average reading noted was 90 to 100 millimeters in the hour. Here it was found that in taking weekly readings, the sedimentation time gave us a definite prognostic indication as to the course of the disease that is with regression of the disease as noted by improvement of joint symptoms, temperature, etc., there was a definite decrease in the blood sedimentation reaction or with further complications, such as increase in joint involvement or cardiac complication, the high sedimentation reading persisted or even increased. Bach and Hill, and Ernestine have made similar observations.

With reference to acute rheumatic fever and its abdominal manifestations, particularly in children, it is interesting to dwell on a paper by Plimpton Guptill in which he decries the need for a method or means to be used in the differential diagnosis of abdominal manifestations of acute rheumatic fever from acute appendicitis. The paper quotes a number of cases with an apparent clinical diagnosis of acute appendicitis, which were operated upon, only to reveal normal appendices, and which subsequently developed fulminating multiple joint symptoms. He remarks

'These cases serve to illustrate the difficulties encountered in differentiating appendiceal

inflammation from the pseudo-appendiceal symptoms of rheumatism, especially in view of the fact that Rolly in a series of 3,500 cases of rheumatic fever studied, found evidence of peritoneal inflammation in only 2 cases, and in neither of these 2 cases was there any involvement of the appendix. It is evident in view of the negative findings in the appendix that the clinician must reconsider the means of diagnosis in the hope that some sign will be developed to differentiate these two diseases.

We feel that we can offer a very substantial and satisfactory aid to this problem in the form of the sedimentation reaction. Every case of rheumatic fever in our study even at its earliest incipient stage, showed a sedimentation reading ranging from a high (60 to 80 millimeters in the hour) to a severe (70 to 130 millimeters in the hour) reaction. On the other hand, every case of appendicitis studied showed an absolutely normal reading (6 to 15 millimeters in the hour). This rather peculiar phenomenon will be discussed in greater detail further on in the paper. It is interesting to quote an illustrative case.

L. B., colored male, aged 12 years, was admitted to the hospital with a diagnosis of acute appendicitis. The onset of illness was with pain in the epigastrium 4 days previous to admission, followed by anorexia, listlessness, and nausea. This pain shifted just before time of admission to the right lower quadrant. On admission, temperature was 101 degrees, pulse 120, respirations 20. There was marked tenderness over McBurney's point and evidence of peritoneal irritation. Rectal examination was confirmatory, but no masses were palpated. The white blood count was 10,500 polymorphonuclears, 85 per cent. band cells, 5 per cent. The sedimentation rate was 104 millimeters in the hour. Because the blood sedimentation reaction was so discordant with that consistently observed by us in acute appendicitis, it was decided to observe the case further. Two days later all abdominal pain disappeared and the patient complained of pain in the right hip in several hours this was followed by the appearance of an acute painful swelling in the right knee.

In this case, we feel that the diagnosis of the abdominal manifestations of acute rheumatic fever was properly differentiated from acute appendicitis with the aid of the sedimentation reaction.

4 Pregnancy and complications. It has been well established since the first observation of

Fahraeus that in pregnancy, beginning with the second month there is a slow graded increase in the sedimentation reading, up to an approximate reading of 45 to 50 millimeters in the hour at term. In incomplete abortions, without sepsis, the blood sedimentation reaction is only slightly higher than that which is normal for the month of pregnancy but with retention of secundines and with onset of sepsis there is a sharp rise in the sedimentation time. In unruptured ectopic gestation, the reading is only slightly higher than that which is normal for the corresponding week of pregnancy. However with rupture and free hemorrhage into the peritoneal cavity the sedimentation reading mounts to 80 to 100 millimeters in the hour varying with the extent of hemorrhage. Friedlander similarly stated "ruptured ectopic pregnancy with fresh blood in the abdominal cavity had a very rapid sedimentation time within the range of acute infections."

5 *Acute and chronic salpingitis (adnexal disease)* Approximately one thousand cases were studied with a number of readings varying between 1 to 12 per case. This field of work has been thoroughly tilled by many investigators. Polak did a great deal of work along these lines and was firmly convinced of the value and efficiency of this laboratory procedure in gynecology. Baer and Reis using the Lanzemeier technique stated that a negative blood sedimentation reaction at the end of 120 minutes rules out pelvic infection. In our hands the Westergren technique as modified seemed more accurate and more practical indicating more clearly the gradations of pathology and necessitating only the hourly reading. A blood sedimentation reaction less than 20 millimeters in the hour was found to be an absolute assurance of the absence of any acute pelvic infection. On the whole our results confirmed those of previous workers and an optimum time for operation, as determined by the blood sedimentation rate was found. All typical clinical cases of acute adnexal disease were found to have hourly readings varying from a low 40 to 50 millimeters to a high 140 to 150 millimeters depending upon the degree and extent of acute pelvic pathology. Sedimentation

readings were taken at weekly or bi weekly intervals to determine (a) progress of case under treatment, (b) optimum time for operation in those cases in which clinical history and pelvic examination so indicated. It was consistently observed that long after temperature white count, pain and tenderness had subsided the more delicate sedimentation reaction became a much more accurate prognosticator as to the most favorable time for operation. No case was operated upon for adnexal disease until the sedimentation rate was below 25 millimeters in the hour. As a result at no time in several hundred operations were acute processes encountered. This observation was well supported by an excellent record of low postoperative morbidity. A sharp contrast in morbidity and postoperative convalescence was seen in those cases operated upon for adnexal disease (before sedimentation readings became routine) in cases in which only clinical and other laboratory findings were used as indication for operation. Several of these cases ran stormy convalescent courses in spite of apparently favorable operability.

6 *The acute surgical abdomen* The acute surgical abdominal cases admitted to the emergency wards presented an interesting study in comparing the sedimentation reaction with the leucocytic response. The first surgical emergencies on which the sedimentation test was done were those of acute appendicitis. *Despite a definitely high leucocytic count in these cases in which definite acute appendiceal pathology was demonstrated at the operating table, we were surprised to encounter a normal sedimentation reaction.* Such pathological states as catarrhal, suppurative, or gangrenous appendicitis caused no deviation from the normal sedimentation reaction. The only forms of appendiceal pathology giving abnormal sedimentation reactions were those of well established abscess or generalized peritonitis of appendiceal origin. On the other hand all other conditions producing the clinical picture of the acute surgical abdomen, showed a definitely abnormal sedimentation reaction.

The abdominal conditions other than acute appendicitis in the order of frequency with

TABLE I—CASE TABULATION OF ACUTE APPENDICITIS

Patient	Hospital No.	Sex	Age	Pathology	W B C	Per cent polym.	Sedimentation reading	
							1 hour	hr
M V	46139	F	18	Acute suppurative appendicitis	7,300	79	6 mm.	1 mm.
E O	48366	M	31	Acute suppurative appendicitis	18,000	87	8 mm.	mm.
A B	143 7	F		Acute catarrhal appendicitis	1,300	65	5 mm.	11 mm.
M A	45615	F	23	Acute gangrenous appendicitis	1,300	84	mm.	4 mm.
M B	41368	F	11	Acute suppurative appendicitis	16,300	89	4 mm.	mm.
I B	40974	F	27	Acute suppurative appendicitis	27,600	91	4 mm.	mm.
J A	1 511	M	19	Acute suppurative appendicitis	530	79	mm.	9 mm.
M M	51139	F	8	Acute gangrenous appendicitis	10,000	83	3 mm.	3 mm.
L E	14018	F	16	Acute gangrenous appendicitis	1,000	80	3 mm.	8 mm.
S W	47131	M		Acute suppurative appendicitis	100	67	3 mm.	mm.
H W	48 73	M	8	Acute suppurative appendicitis	100	70	4 mm.	mm.
T M	40573	M	7	Acute gangrenous appendicitis	1,400	67	4 mm.	mm.
C V	51979	F	6	Acute gangrenous appendicitis	14,000	80	3 mm.	7 mm.
M A	39698	F	7	Acute gangrenous appendicitis	9,300	76	4 mm.	8 mm.
M W	51 14	F	45	Acute suppurative appendicitis	18,330	8	4 mm.	10 mm.
A M	1 147	F	15	Acute catarrhal appendicitis	1,800	79	mm.	mm.
D E	50079	F		Acute catarrhal appendicitis	10,800	79	5 mm.	10 mm.
E H	11166	F		Acute gangrenous appendicitis	1,300	8	mm.	9 mm.
D W	5711	F		Acute suppurative appendicitis	6,500	70	mm.	8 mm.
O R	7136	F	9	Acute catarrhal appendicitis	19,300	74	3 mm.	mm.
T P	1 30	M	1	Acute gangrenous appendicitis	17,600	9	mm.	3 mm.
T C	1038	M		Acute suppurative appendicitis	1,600	78	mm.	mm.
V G	10478	F	19	Acute catarrhal appendicitis	1,300	74	mm.	mm.
P B	40990	F		Acute gangrenous appendicitis	19,000	90	8 mm.	mm.
P F	498	M	1	Acute gangrenous appendicitis	1,300	78	mm.	5 mm.
H K	11307	F	30	Acute catarrhal appendicitis	1,300	78	mm.	7 mm.
V R	4070	M		Acute suppurative appendicitis	16,800	81	mm.	9 mm.
M K	47 18	F	1	Acute suppurative appendicitis	10,000	86	mm.	6 mm.
D S	11495	M		Acute gangrenous appendicitis	7,000	78	3 mm.	8 mm.
E B	10039	F	5	Acute catarrhal appendicitis	6,300	78	mm.	9 mm.
J V	26301	M	14	Acute suppurative appendicitis	1,000	83	mm.	mm.
L K	5190	F	23	Acute catarrhal appendicitis	10,300	83	3 mm.	7 mm.
L V	26301	M	30	Acute suppurative appendicitis	1,300	75	8 mm.	5 mm.
P L	14180	M	1	Acute suppurative appendicitis	1,000	87	mm.	9 mm.
J C	5117	M	14	Acute catarrhal appendicitis	10,800	80	mm.	6 mm.
W D	11393	M	6	Acute catarrhal appendicitis	9,800	66	mm.	8 mm.
W G	14139	M	1	Acute gangrenous appendicitis	1,300	81	4 mm.	mm.
J K	26114	M	30	Acute suppurative appendicitis	4,800	80	4 mm.	mm.
G V	15663	M	9	Acute suppurative appendicitis	11,800	81	3 mm.	9 mm.

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TABLE I—CASE TABULATION OF ACUTE APPENDICITIS—Continued

Patient	Hospital No	Sex	Age	Pathology	W.B.C.	Per cent polya.	Sedimentation reading	
							15 min.	1 hr.
E. C.	35703	M	3	Acute gangrenous appendicitis	12,400	81	8 mm.	8 mm.
P. C.	35847	F	18	Acute catarrhal appendicitis	12,000	70	8 mm.	8 mm.
C. H.	35851	M	21	Acute suppurative appendicitis	11,000	84	3 mm.	7 mm.
A. E.	33770	F	23	Acute catarrhal appendicitis	7,800	84	3 mm.	10 mm.
K. Z.	33968	F	19	Acute suppurative appendicitis	7,800	84	3 mm.	5 mm.
M. E.	34018	F	16	Acute suppurative appendicitis	12,000	81	3 mm.	6 mm.
J. B.	3900	M	25	Acute suppurative appendicitis	15,400	84	3 mm.	8 mm.
M. C.	34160	F	8	Acute catarrhal appendicitis	10,000	78	3 mm.	10 mm.
H. E.	34158	M	1	Acute catarrhal appendicitis	10,000	73	mm.	0 mm.
A. S.	35713	M	34	Acute suppurative appendicitis	13,000	86	3 mm.	8 mm.
D. S.	30324	M	26	Acute gangrenous appendicitis	17,500	87	3 mm.	10 mm.
W. T.	30280	M	23	Acute suppurative appendicitis	13,000	80	3 mm.	8 mm.
C. O.	37041	M	26	Acute suppurative appendicitis	13,000	84	3 mm.	5 mm.
T. A.	33901	M	30	Acute suppurative appendicitis	12,900	80	3 mm.	7 mm.
H. C.	31635	M	27	Acute suppurative appendicitis	15,000	84	3 mm.	5 mm.
A. F.	33548	M	38	Acute gangrenous appendicitis	13,000	84	3 mm.	12 mm.
A. B.	34433	M	6	Acute suppurative appendicitis	14,000	85	3 mm.	17 mm.
L. Z.	33543	M	24	Acute gangrenous appendicitis	15,000	80	3 mm.	8 mm.
R. H.	34511	M	43	Acute catarrhal appendicitis	16,500	85	3 mm.	11 mm.
J. B.	30900	M	21	Acute suppurative appendicitis	14,400	86	3 mm.	10 mm.
G. C.	37738	M	23	Acute gangrenous appendicitis	14,300	81	3 mm.	11 mm.
E. C.	34410	M	10	Acute suppurative appendicitis	14,300	81	3 mm.	9 mm.
T. P.	33870	M	20	Acute suppurative appendicitis	11,800	78	3 mm.	0 mm.
H. R.	34073	F	20	Acute suppurative appendicitis	11,000	81	3 mm.	0 mm.
M. C.	49138	F	19	Acute suppurative appendicitis	14,000	86	3 mm.	8 mm.
A. F.	3444	F	8	Acute gangrenous appendicitis	10,600	78	3 mm.	9 mm.
D. L.	34120	F	3	Acute suppurative appendicitis	12,400	73	3 mm.	5 mm.
A. N.	On ward	F	21	Acute suppurative appendicitis	16,800	88	3 mm.	14 mm.
J. P.	On ward	M	8	Acute suppurative appendicitis	7,400	80	3 mm.	6 mm.
F. P.	On ward	M	10	Acute catarrhal appendicitis	10,000	84	3 mm.	5 mm.
T. S.	On ward	M	24	Acute catarrhal appendicitis	11,800	85	3 mm.	7 mm.
L. G.	On ward	F	9	Acute gangrenous appendicitis	12,000	83	3 mm.	9 mm.
T. M.	On ward	F	34	Acute gangrenous appendicitis	12,000	81	34 mm.	80 mm.
W. W.	On ward	M	41	Acute gangrenous appendicitis	18,700	80	30 mm.	85 mm.

*These patients returned to tuberculous parison after recovery from appendicitis and one month later showed the same blood sedimentation reaction as pre-operatively. High blood sedimentation reaction due to bilateral chronic pneumonic tuberculosis.

TABLE II.—CASE TABULATION OF CONDITIONS OTHER THAN ACUTE APPENDICITIS

A. Appendical Abscesses

Patient	Hospital No.	Sex, Age	Pathology	W B C	Per cent polys	Sedimentation reading		Remarks
						1st hr.	hr.	
L. DeL.	33746	F 43	Appendical abscess—appendix ruptured	15,000	76	30 mm.	48 mm.	First operation abscess drained. Second operation (25 R. 30 mm.) subperitoneal found and drained. Postoperative—25 R. gradually fell to normal.
J. W.	54180	M 43	Appendix sloughed off—large abscess present	75,000	84	mm.	17 mm.	
J. T.	54895	M 38	Appendical abscess	11,000	84	70 mm.	80 mm.	
C. S.	53777	M 54	Appendical abscess	6,000	83	mm.	14 mm.	
T. J.	5769	F 25	Retrocecal abscess	2,000	76	4 mm.	17 mm.	
E. D.	13040	F 13	Appendical abscess	8,000	86	16 mm.	23 mm.	
F. A.	47823	F 70	Appendical abscess and gangrene of cecum	20,000	90	18 mm.	40 mm.	

B. Generalized Peritonitis of Appendical Origin

M. L.	60044	F 23	Appendix ruptured—peritoneal fluid cloudy	16,000	88	7 mm.	16 mm.	History of 16 hours duration
J. M.	54869	M 3	Appendix gangrenous—cloudy fluid free in peritoneum	17,300	83	10 mm.	30 mm.	
J. P.	839	M 9	Appendix ruptured	14,000	87	21 mm.	30 mm.	Peritoneal fluid cloudy—positive B. coli culture. Patient died
M. H.	17	F 44	Appendix ruptured	1,000	91	40 mm.	50 mm.	Free pus in peritoneal cavity. Patient died days after operation.
F. H.	5137	M	Appendix gangrenous	5,000	84	11 mm.	25 mm.	Mediastitis, chest sorefulness found in peritoneal cavity
H. M.	13837	F 36	Appendix ruptured	9,000	94	30 mm.	70 mm.	Free pus in peritoneal cavity. Patient was 3 months pregnant. Aborted month after operation.
B. K.	44	M 41	Appendix ruptured	10,000	83	13 mm.	50 mm.	Free pus in peritoneal cavity. Patient died

C. Tabulation of Extra-Appendical Conditions

D. B.	5178	M 38	Acute hepatic abscess of liver	8,000	78	40 mm.	17 mm.	Pre-operative diagnosis was ruptured gastric ulcer.
R. S.	368	F	Autopsy showed bilateral pleurisy with effusion	20,000	61	13 mm.	704 mm.	Patient operated on for appendicitis. Appendix normal. Patient died 24th postoperative day.
M. D.	53	F 54	Ruptured gangrenous gall bladder with peritonitis	1,000	81	30 mm.	56 mm.	Pre-operative diagnosis was appendicitis. Patient died 24th postoperative day.
R. C.	804	F 40	Operation revealed intestinal obstruction	10,000	88	30 mm.	70 mm.	Pre-operative diagnosis was acute appendicitis. Appendix normal. Three hours of intestine found gangrenous. Ruptured. Patient died of postoperative pneumonia.
T. R.	53408	F 14	Acute subpyrexia	1,000	80	mm.	13 mm.	Pre-operative diagnosis was appendicitis. Operation revealed bilateral subpyrexia.
A. C.	13041	F 11	Acute pyrexia demonstrated by cytology, pyelography	14,000	74	18 mm.	30 mm.	Admission diagnosis was acute appendicitis.
M. T.	19823	F 30	Acute subpyrexia	1,000	76	mm.	66 mm.	Pre-operative diagnosis was acute appendicitis.
M. C.	51300	F 46	Acute cholecystitis, cholelithiasis	1,700	74	40 mm.	8 mm.	Admission diagnosis was acute pyrexia. Operation revealed gall bladder pathology.
L. M.	47857	F 33	Acute cholecystitis	10,000	66	30 mm.	73 mm.	Stones present in gall bladder.
A. W.	13043	F 18	Fluoritis with effusion	9,300	74	mm.	70 mm.	Patient operated on for acute appendicitis. Appendix found normal. Patient subsequently showed pleurisy with effusion.
E. W.	1093	F 37	Strangulated femoral hernia	10,400	81	8 mm.	47 mm.	Admission diagnosis was appendicitis. Operation revealed strangulated hernia with hemorrhage found.

TABLE II.—CASE TABULATION OF CONDITIONS OTHER THAN ACUTE APPENDICITIS—Continued
C. Tabulation of Extra-Appendiceal Conditions—Continued

Patient	Hospital No.	Sex, age	Pathology	W.B.C.	Percent polys	Sedimentation reading		Remarks
						13 mts.	1 hr.	
F P	43395	M 37	Ruptured duodenal ulcer	18,000	82	70 mm.	66 mm.	Rupture in first portion of duodenum. Free intraluminal contents in peritoneum
J D	41161	M 56	Ruptured gastric ulcer	14,400	73	31 mm.	73 mm.	Perforation on anterior surface of stomach. Free gastric contents in peritoneum
M. T	51170	F 24	Tubal pregnancy and hematosalpinx	1,300	84	50 mm.	70 mm.	
A V	45370	F 31	Ruptured ectopic pregnancy	17,800	80	70 mm.	150 mm.	Abdomen found filled with blood
T. B.	14039	F 26	Tubal abortion	13,800	84	8 mm.	44 mm.	Admission diagnosis acute appendicitis
F A.	14337	F 30	Ruptured ectopic pregnancy	11,000	70	8 mm.	33 mm.	Moderate collection of blood in pelvis
A. F	53312	M 25	Gonococcus serosal vasculitis	16,400	80	18 mm.	68 mm.	Admission diagnosis was acute appendicitis
A S	54406	F 16	Acute appendicitis with gangrenous caecum	18,500	90	15 mm.	67 mm.	
A. M	515	F 46	Autopsy showed vegetative endocarditis and pericarditis	13,400	90	30 mm.	140 mm.	Admission diagnosis was acute appendicitis. Patient died later on medical service
M. K.	39060	M 40	Acute phlegmonous gall bladder	10,900	80	15 mm.	68 mm.	
C. C.	37007	M 19	Tuberculous peritonitis	11,400	74	15 mm.	110 mm.	
S. G.	33	M 33	Tuberculous peritonitis Tuberculous abscess of liver	14,000	85	35 mm.	120 mm.	Patient died after prolonged illness
S. T	43407	M 34	Ruptured malignant ulcer	19,500	80	15 mm.	40 mm.	
S. M	3041	M 28	Tuberculous peritonitis	14,800	81	15 mm.	140 mm.	Period of convalescence for 6 months following laparotomy. Patient died 1 year later
H. G	On ward	F 36	Ruptured gangrenous gall bladder	10,000	94	10 mm.	35 mm.	Cholecystectomy done; uneventful recovery
G. D	51930	F 19	Bilateral pyosalpinx	10,800	83	30 mm.	80 mm.	
A. W	51517	F 21	Bilateral pyosalpinx	14,700	81	30 mm.	65 mm.	
J. P	54079	M 61	Ruptured gangrenous gall bladder	11,400	81	8 mm.	35 mm.	Cholecystectomy recovery
J. B.	On ward	M 26	Casuous pneumonic tuberculosis	7,600	76	8 mm.	70 mm.	Admission diagnosis was acute appendicitis
A. S	On ward	F 34	Ruptured ovarian cyst	10,300	81	6 mm.	25 mm.	Admission diagnosis was acute appendicitis

which they were found at the Metropolitan Hospital, were as follows

Acute adnexal disease All cases of acute adnexal disease give a sedimentation reaction varying from high to severe (60 to 120 millimeters in the hour) depending upon the extent and virulence of the infection. This fact becomes one of utmost importance, especially so at this institution, where so many cases of acute adnexal disease are admitted with very vague history and clinical findings pointing to the right lower quadrant. The ordinary clinical and laboratory measures, in a good number of cases, have frequently left us undecided as to a definite diagnosis particularly between appendicitis and salpingitis. It soon became evident that the sedimentation reaction offered us a new and distinct aid in the differential diagnosis in this classical dilemma

between acute salpingitis and acute appendicitis, that is, salpingitis giving a consistently abnormal blood sedimentation reaction and appendicitis a consistently normal one.

The acute surgical gall bladder The acute surgical gall bladder varying from acute suppurative to ruptured gall bladder gives a sedimentation reaction varying from moderate (25 to 40 millimeters in the hour) to high (60 to 80 millimeters in the hour)

Ruptured peptic ulcer Similarly the ruptured peptic ulcer with free fluid in the peritoneal cavity gives an abnormal reaction varying from moderate to severe depending upon the duration of rupture.

Tuberculous peritonitis Tuberculous peritonitis is occasionally met with as a surgical differential from appendicitis and here again this disease falls into the category of those

conditions yielding abnormal sedimentation readings, usually 75 to 90 millimeters in the hour.

Acute conditions of the genito-urinary tract Acute conditions of the genito-urinary tract such as pyonephrosis, pyelitis, ureteral calculus, and seminal vesiculitis, have on occasion simulated acute appendicitis. In these cases the blood sedimentation reaction has been consistently high.

Masked chest conditions with abdominal manifestations That group of acute chest conditions with referred abdominal manifestations has also entered into a differential diagnosis of the acute surgical abdomen thus several cases with apparently acute surgical conditions of the abdomen and high sedimentation readings have subsequently proved to have acute pulmonary pathology such as central pneumonia and acute tuberculosis.

Miscellaneous conditions with acute abdominal manifestations Such conditions as ruptured ovarian cyst ruptured ectopic pregnancy mesenteric thrombosis, and acute mesenteric adenitis have on occasion entered into the differential diagnosis of the acute surgical abdomen. These conditions have all shown definitely abnormal sedimentation reactions.

TABULATION OF CASES AND COMMENT

We have grouped the cases studied into the following tables. Table I consisting of all cases of acute appendicitis. Table II consisting of a group of other surgical conditions encountered.

Table I demonstrates a clinical, laboratory and operative study of 75 consecutive cases of acute appendicitis falling into the pathological classification of acute catarrhal, gangrenous, and suppurative. It is uniformly observed that the sedimentation reaction regardless of pathology noted has been normal. Age, sex, and casual individual factors do not alter in any appreciable manner the sedimentation reaction in this group of cases. The white counts are found to vary from normal (7,000) to 30,000 and the percentage of polymorphonuclears varies from 65 to 95 per cent without any bearing or relationship to the consistently normal blood sedimentation

reaction. In those cases in which Schilling or Arneth indices were done, no relationship to the sedimentation reading was noted.

Table II enumerates that group of cases other than acute appendicitis as proved at operation or by subsequent clinical course of the condition. A study of this group of cases illustrates the variety of conditions encountered in the surgical differential diagnosis of the acute appendix. The sedimentation readings were uniformly abnormal, regardless of the diagnosis. No consistent relationship between the white cell count and blood sedimentation reaction was noted although in some cases, e.g., in extensive suppuration high sedimentation readings were accompanied by high white cell counts. It is important to note that cases of appendiceal abscess are grouped under Table II inasmuch as such cases present a definite distinction, both on a clinical and pathological basis, from acute appendicitis *per se*. These cases have shown distinctly abnormal readings, varying from 40 to 100 millimeters in the hour; likewise, frank cases of generalized peritonitis though appendiceal in origin are grouped in the above table.

To demonstrate the value of the sedimentation reaction as an aid to differential diagnosis, we wish to quote several of the numerous cases encountered in which the sedimentation reaction proved to be a distinct guide to diagnosis.

CASE 1. D. L., a colored female child, 10 years of age, was admitted to the hospital with a diagnosis of acute appendicitis. Thirty-six hours before admission she was seized with severe pain in the epigastrium soon followed by nausea and vomiting. On admission the pain was described as having migrated to the umbilicus and lower right quadrant. Past history was essentially negative. On examination there was found marked tenderness in the right lower quadrant and slight spasm. The temperature was 99, pulse 100, respirations 22. The white blood count was 10,700—polymorphonuclears 71 per cent; the blood sedimentation rate was 40 millimeters in the hour. Because of aggravation of symptoms, laparotomy was done, revealing an acute salpingitis with normal appendix.

CASE 2. A. F., adult colored male, aged 24 years, was admitted to the hospital with diagnosis of acute appendicitis. There was a history of pain in right lower quadrant for past 2 days with nausea but no vomiting. He had taken an enema and cathartic

with aggravation of symptoms. On examination the patient was found to be acutely ill; temperature was 100, pulse 100, respirations 22. There was spasm and tenderness with hyperaesthesia of the right lower quadrant. On rectal examination, an acutely tender boggy seminal vesicle was palpated on left side. On further questioning the history was obtained of gonococcal arthritis 4 years previously with recurrence of slight urethral discharge 1 month ago. The white blood count was 10,400, 75 per cent polymorphonuclears, blood sedimentation rate 65 millimeters in the hour. The urine showed moderate pus cells and shreds. The patient was transferred to genito-urinary service where he underwent treatment for seminal vesiculitis with relief of condition.

CASE 3. J. B. Porto Rican male, aged 26 years, was admitted with diagnosis of acute appendicitis. Three days before admission patient began to suffer severe right lower quadrant pain followed by nausea and vomiting. On examination, patient appeared acutely ill, temperature was 101, pulse 120, respirations 22. There was marked muscle spasm and tenderness in right lower quadrant. The white blood count was 7,600, polymorphonuclears 67 per cent, blood sedimentation rate 70 millimeters in the hour. Further examination, with X ray and fluoroscopy revealed an acute caseous pneumonic tuberculosis of the right apex, despite the fact that there were no symptoms referable to the chest. Shortly thereafter the abdominal symptoms subsided entirely and the patient is now receiving pneumothorax treatment.

CASE 4. W. C. 35 year old married Porto Rican female, was admitted with diagnosis of acute appendicitis. There was a history of recurrent attacks of pain in right lower quadrant, the last attack being of 24 hours' duration. The temperature was 102 degrees, pulse 110, respirations 24. There was tenderness, spasm, and rigidity over right lower quadrant extending posteriorly to the flank. The white blood count was 13,400—88 per cent polymorphonuclears, sedimentation time 114 millimeters in the hour. The urine showed albumin 3 plus, occasional red cells and moderate pus cells. Cystoscopy and pyelography revealed a pyohydronephrosis with stone in pelvis.

CASE 5. A. W. white female, aged 17 years, was admitted to hospital with diagnosis of acute appendicitis. There was a history of an attack of pain in right iliac region radiating to right lower quadrant 1 day previous to admission; there was nausea but no vomiting. The patient had had similar spasmodic attacks of pain during the past 2 years. On examination, patient appeared acutely ill; temperature was 103 degrees, pulse 114, respirations 24. The abdomen revealed tenderness and spasm below and to the right of the umbilicus. The white blood count was 10,200—76 per cent polymorphonuclears, blood sedimentation rate 70 millimeters in the hour. Appendectomy was performed and appendix was found to be entirely normal. After operation, the patient developed signs of increasing fluid in the right

chest, these findings were confirmed by X ray, chest was tapped and patient placed under medical treatment.

SURVEY OF THE LITERATURE

On completion of the work outlined, it was interesting to survey the contemporary literature on the subject. The references were comparatively meagre and on the whole discordant. M. Cattaneo in 1932 studied 40 cases of acute and chronic appendicitis. His conclusions are completely contradicted by our results. He states "In subacute and chronic appendicitis, the sedimentation velocity of erythrocytes increases with the increase in leucocytes. In acute appendicitis, the sedimentation velocity increases also in those cases in which no increase in leucocytes appears—but as it seems more constant in acute cases and is earlier as compared to the leucocytosis, it may furnish useful indications in appendicitis—as to the existence of the inflammatory condition." It will be readily seen that the conclusions drawn by this writer in a short series including chronic cases is contradicted in every respect by our results. M. Montanari Reggiani studied the "Numerical variations of the leucocytes and the conduct of the sedimentation rate in cholecystitis, appendicitis and adnexitis." We agree with his general observation that there exists in none of these infections a specific conduct or a correspondence between a degree of leucocytosis and the time of sedimentation but we thoroughly disagree with his impression that no differential diagnostic data between these three diseases can be obtained. The essential purpose of our study after a two thousand case series is to clearly demonstrate the striking value of the blood sedimentation reaction in the differential diagnosis of appendicitis.

E. G. Bannick presents an excellent paper on the sedimentation reaction covering a wide variety of conditions. His generalizations are concise, and our studies concur in every respect with his results. We have independently concluded as he does that "the chief information concerning the rapidity of the sedimentation of the blood is provided during the first hour—and the simplest way of expressing this is by measuring in millimeters

TABLE III.—AGE AND SEX IN SKIN MALIGNANCIES

	Age																		Sex	
	6	9	16	19	30	1	2	3	24	25	26	27	28	29	30	31	32	M	F	
Basal cell epithelioma							2			4			2			6	4			
Squamous cell epithelioma	1		1			1			1	1		1				6	3			
Nævus cell carcinoma		1	1		1				1			1	1			8	1			

Twenty seven patients suffering from malignant disease of the skin were 30 years of age or younger. Of these 10 had basal cell epitheliomata, 8 squamous cell epitheliomata, and 9 nævus cell carcinomata.

The 10 basal cell lesions all began as small sores or pimples which did not heal. Two of the patients gave a history of a burn as the beginning of their present illness and one, the history of cutting himself several times with a razor. The duration of these symptoms varied from 6 months to 10 years.

All but one of the lesions were treated successfully. That is, all healed following original treatment. One was lost trace of 1 month later, the remainder have been well for periods varying from 1 year to 18 years with the exception of the patient who had two lesions, one on the left lower eyelid and one on the right lower eyelid.

This patient had both lesions at the time of admission. Both healed with radiation treatment but the right one recurred after 3 years. The lesion was re-treated but the patient neglected the condition and did not report for re-examination until the lesion was far advanced. Irradiation was again tried but was unsuccessful. Eventually the entire orbital contents and eyelids were coagulated, but the disease spread gradually causing death 10 years after admission. The lesion on the other eyelid remained healed at the time of death.

Treatment of the squamous cell lesions also met with considerable success. Five of the 8 patients have remained clinically well following original treatment for periods varying from 1 year to 6 years, 1 patient was unimproved and lost in 1 month, 2 were progressively worse and died from the disease. Both of these latter patients gave a history of having been treated with X ray for lupus for several years before admission. Two other patients gave a history of having been burned at the site of the lesion one of being cut with

a razor at the site of a wart, and another lesion occurred at the site of a birthmark.

These skin malignancies were treated by means of unfiltered X rays, two to five times the erythema dose, in one sitting, radium plaques, or filtered radium. The regional lymph nodes in the squamous cell cases were treated by means of 200 kilovolt X rays or large radium packs. In some cases surgery or coagulation was resorted to according to indications.

There were 9 cases of nævus cell carcinoma. Three of these patients gave a history of a growth of a mole which had existed since birth. Only 1 patient gave a history of injury at the site of the lesion. All the lesions were removed surgically and treated with 200 kilovolt X rays or radium packs. The result of this treatment is as follows.

One patient is alive and well 9 years 5 months after treatment, 1 patient was clinically well for 2 years 5 months when there was a recurrence and he died 5 years 9 months after admission from general carcinomatosis, 1 patient was well for 8 months and then there was a recurrence. He eventually died from the disease 3 years 7 months after admission. Four patients died within a year with no improvement, 2 were lost trace of in 6 months and 8 months respectively. Both were unimproved.

It is a fact that most basal cell and squamous cell epitheliomata, and also nævus cell carcinomata, occur later in life the majority occurring after the age of 40.

ORBITAL CAVITY

There were 20 cases of malignancy involving the orbital cavity in patients under 30 years of age. Twelve were retinoblastomata (gliomata) 2 squamous cell epitheliomata of the conjunctiva, 1 basal cell epithelioma of

TABLE IV—AGE AND SEX IN ORBITAL CAVITY TUMORS

	Age												Sex	
	1	2	3	4	5	6	7	8	9	10	11	12	M	F
Retinoblastoma (gloma)		1	1										2	1
Epithelioma conjunctivae														
Basal cell epithelioma corneae													1	
Carcinoma lacrimal gland										1				1
Sarcoma					1									

the cornea 2 carcinomata of the lacrimal gland and 3 sarcomata. Table IV shows the age and sex of these patients.

Retinoblastoma is a disease which usually occurs in children. Most of the cases occur before the age of 5 years. Usually parents or guardians discover some abnormality in sight from the actions of the children and finally notice a dilated pupil with a grayish color. These symptoms were noted as early as 6 weeks after birth in our group of cases. In 1 of our cases 83 per cent the disease was bilateral. Stout quotes Morav as saying that 28 per cent of these tumors are bilateral.

If seen fairly early there is a fair prospect of surgical cure. When the disease has permeated the globe (the glaucomatous stage) or penetrated the globe, the prognosis is grave. Stepka, as quoted by Stout, says that in all cases where it had perforated the globe the results were bad. Ten of our cases had had enucleation of the affected eye. All were treated by radiation, either 200 kilovolt X-rays, or radium applications. Eight died in less than a year 1 was lost trace of in 3 months, the result undetermined, 1 was lost trace of 2 years after admission, at which time there was no recurrence 1 was clinically well for 9 months and then lost trace of and one has been clinically well for 3 years and 4 months following surgical removal and irradiation.

Both cases of squamous cell epithelioma of the conjunctiva were biopsied and treated with a large amount of radon lightly filtered and have remained clinically well since the time of original treatment. The one, a 19 year old male, for 10 years the other an 18 year old female, for 2 years.

The basal cell epithelioma of the cornea occurred in a 16 year old male. This lesion was biopsied and treated with a large amount of radon lightly filtered and has remained clinically well for 1 year and 7 months since treatment.

The 2 carcinomata of the lacrimal gland were tumors of the mixed salivary type. Both were treated by radiation followed by surgical removal of the tumor. One patient died in 1 year from metastases throughout the skull and scalp and the other patient lived over 6 years and was free from recurrence at last observation. Both were females, aged 17 and 28 years respectively.

The 3 other cases of malignancy involving the orbit were sarcomata.

One was a round cell sarcoma in a 15 month old female. The eyeball was enucleated and the tumor removed but the baby died the following day. Autopsy revealed metastases to the lungs, kidneys, and bladder.

The second case was in a 14 year old male and biopsy showed a mixed cell sarcoma containing spindle round, and myxosarcoma. The tumor was dissected from the orbit and radium needles were inserted following which he was clinically well for 7 months. The lesion then recurred and was again treated with the insertion of radium needles and the application of the 4 gram radium pack. He has been clinically well for the past year.

The third, in a 30 year old female, was a melanoma which was treated with 200 kilovolt X-rays followed by enucleation of the eye. This patient died 4 years 6 months after admission, from recurrence of the lesion in the orbit and spinal metastases.

BRAIN

There were two brain tumors. One was a cerebellar tumor in a 6 year old male on whom a decompression had been done before admission. This child complained of headaches, and

had been troubled by nausea and vomiting for 3 months. He was treated with 200 kilovolt X rays and he died 3 months after admission. The second case was a medulloblastoma of the floor of the fourth ventricle in a 12 year old female. Tissue had been removed at the time of admission and 200 kilovolt X-rays were given. This child had palliation for 7 months when there was a return of her symptoms and progression of the disease and she died 1 year after admission.

LIP

There were 4 cases of epithelioma of the lip (10), in patients aged 25 27 28 and 29 years, respectively. All were males. In 3 the lesion was confined to the lip and there were no palpable nodes in the neck in the fourth there were small nodes in both the right and left submaxillary regions. All of these patients used tobacco and all had poor oral hygiene, 2 had positive Wassermann reactions. The sections in all the cases were found to be squamous cell epitheliomata. All have remained well since treatment except that 1 still has a small palpable node in the submaxillary region, 1 remained well for 2 months and was then lost trace of 1 for 6 years, 1 for 8 months, and 1 for 7 months (this is the one with the node). These cases were treated with unfiltered X rays to the lip and 200 kilovolt X rays to the lymph bearing areas. These patients gave histories of a cold sore scabbed lesion, or small ulcerations which had existed for from 3 months to 1 year.

ORAL CAVITY

There were 23 cases of malignancy involving the oral cavity in which the patients were under the age of 30 years. One was a papilloma-like growth inside the upper lip in a 23 year old female which showed beginning epithelioma and was treated by the implantation of radon seeds. The tumor regressed following treatment but the patient was lost from observation.

There were 11 cases of malignancy of the gum 3 were epitheliomata in 18 22 and 26 year old males, all used tobacco oral hygiene was fair; one had a positive Wassermann reaction. Biopsy in the 3 cases showed epithelioma.

The histories given were of a growth or sore which had been noticed for from 2 months to 2 years. All of these lesions involved a large area. Two of the patients were treated with radium applied to the lesion and 1 of these also had excision of the whole lesion the third was treated with 200 kilovolt X rays only. All died within a year.

There were 5 cases of adamantinoma of the jaw in patients aged 4, 12 14, 25 and 28 years 2 were females and 3 were males the Wassermann was positive in 1 case all the lesions occurred at the site of carious teeth or some abnormal dental condition.

The lesion in the 12 year old female was not treated, the rest had removal of the tumor mass followed by radium applications.

The 4 year old male was lost trace of in 1 year 11 months the lesion had progressed.

The 14 year old male died 10 years 9 months after admission. The tumor had grown very large, ulcerated, perforated the cheek, and caused a large swelling at the side of the head, but he had had palliation for a number of years. Resection of the jaw had been refused in this case.

The 5 year old male was clinically well for 1 month when he was lost from observation.

The 25 year old female, a colored woman, was clinically well for 3 years. Since then the lesion has recurred on 3 occasions. Curettage and irradiation have been palliative over a period of 10 years.

One case, a 11 months old male, had an injury to the jaw followed by tumor formation. Section of this showed round cell sarcoma. He was treated with 200 kilovolt X-rays followed by complete disappearance of the tumor. The baby died 3 1/2 months later from other causes. A fibromyxosarcoma of the gum occurred in a 5 year old male and involved the jaw bone. This was removed surgically and then treated with 200 kilovolt X-rays and there has been no recurrence for 2 years 9 months.

An alveolar sarcoma occurred in a 19 year old female. This was treated with a large amount of radon lightly filtered, and the implantation of radon seeds. This patient has been clinically well for the past 2 years.

Four of these malignancies of the oral cavity occurred on the palate.

One was an epithelioma in the soft palate area with a palpable node in the right submaxillary region in a 13 year old male. The lesion was treated by the implantation of gold radon seeds and the nodes in the submaxillary region were treated with 200 kilovolt X-rays. This patient has been clinically well for 3 years.

TABLE V—AGE AND SEX—ORAL CAVITY AND LIP MALIGNANCIES

	Age																				Sex	
	4	5			1	2	3	4	5	6	7	8	9	10		11	12	13	14	15	16	17
Epithelioma																						
Adenoma																						
Sarcoma																						

Two were myxosarcomata.

One occurred in a 29 year old male and involved the hard and soft palate regions. He was treated with radium packs but died 11 days after admission from acute dilatation of the heart. Autopsy revealed that this lesion had invaded the bone.

The other myxosarcoma occurred in a 10 year old female and involved the soft palate with a peritonsillar node on the right side. This patient remained clinically well 2 years 11 months following treatment with 200 kilovolt X rays but the lesion then recurred, causing her death 3 years 4 months after admission.

The fourth case was a fibrosarcoma in the hard palate in a 25 year old male which was treated with radon seeds. He has remained clinically well for 3 years.

Three of the cases involved the tongue all lesions were squamous cell epitheliomata showing pearls and occurred in 24 and 30 year old males and a 30 year old female. None of these patients used tobacco. In 1 case the teeth were in very bad condition and a second patient had been undergoing treatment for syphilis all the Wassermann reactions were negative at the time of admission. The symptoms given were those of a "sore" on the tongue which had been present for 2 or 3 months in each case.

The growth in the 24 year old male was very far advanced with a large tumor mass in the submandibular region which was fixed to the jaw bone. X ray treatments with 200 kilovolt X rays were given but the patient died without palliation in 5 months.

The lesion in the 30 year old male involved the left side of the tongue at the junction of the middle and posterior thirds and looked like an old lentic lesion undergoing malignant change. This was treated with radon seeds into the tongue and 200 kilovolt X-rays to the neck. The patient was clinically well for 10 months when he committed suicide.

The lesion in the 30 year old female involved the left side of the tongue near the base. It was treated by the implantation of radon seeds and 200 kilovolt X rays the patient died in 3 months without improvement.

One case, an epithelioma of the tonsil and base of the tongue was treated by the implantation of radon seeds and the radium pack. Within 1 month radical surgery was done at another hospital. The patient died 8 months after admission from the disease.

Three cases occurred in the pharynx, 1 was a transitional cell epithelioma in a 14 year old male and involved the posterior pharyngeal wall. It was a hard fixed lesion 4 centimeters in diameter with palpable nodes in both sides of the neck.

This patient was treated with the 4 gram radium pack and has remained clinically well for 2 years.

The second case was a lymphosarcoma in the pharynx with a hard metastatic node in the peritonsillar region. It was treated by means of radon seeds implanted into the tumor and 200 kilovolt X rays to the neck. The patient died in 4 months.

The third case was a spindle cell sarcoma of low grade malignancy in a 27 year old colored male, which involved the pharynx, arising from the left side of the base of the tongue. This entire tumor mass was removed surgically but the patient was lost trace of 2 months later.

NASAL CAVITY

There were 15 cases of malignancy which occurred in the nasopharynx: 5 epitheliomata, 4 lympho-epitheliomata, and 6 sarcomata. Table VI shows the ages and sex of these patients.

The symptoms in the cases of epithelioma, lympho-epithelioma, and lymphosarcoma had existed in most instances for from 2 to 6 months in only 2 cases for more than 6 months. These symptoms were headaches, sore throats, or earaches, followed by shortness of breath, obstruction to breathing in one or both nostrils and in most cases, swelling of the nodes in the neck, either one or both sides. Two patients had bleeding from the nose and 2 mucous discharge from the nose. Several complained of difficulty in swallow-

TABLE VI.—AGE AND SEX—NASAL CAVITY MALIGNANCIES

	Age																Sex	
	9	14	17	18	19	20	1	2	21	24	25	26	27	28	29	30	M	F
Epithelioma				1		1						1				1	4	1
Lympho-epithelioma		1	1				1			1							2	2
Lymphosarcoma								1		1							1	
Alveolar sarcoma				1													1	
Myxosarcoma	1	1															2	

lowing and 2 coughed up phlegm and blood. The 2 patients with myxosarcoma gave histories of longer duration, one 3 years and the other 9 years. This latter child was thought to have adenoids breathing gradually became completely obstructed and at the time of admission the growth filled both nostrils and the pharynx.

The 5 cases of epithelioma had biopsies.

The 18 year old female was treated with 500 kilovolt λ rays. She died in 2 days from an embolism and autopsy showed metastases in the liver.

The 20 year old male was treated by the implantation of radon seeds and further treatment had been planned. He did not return, however, after this preliminary treatment and died 5 months after admission.

The 3 other cases were treated by radon seed implantation into the nasopharynx and external irradiation—500 kilovolt λ rays or radium packs—to both sides of the neck. In one case the lesion in the nasopharynx completely disappeared but 8 months after treatment a metastasis developed in the groin and the patient died 13 months after admission from metastases in the liver pelvis, and retroperitoneal nodes. The lesion in the nasopharynx remained well at the time of death.

The 2 other patients died in 6 months and 2 years 2 months, respectively from progression of the disease.

There were 4 cases of lympho-epithelioma occurring in 14 and 24 year old females and 17 to 21 year old males. All were treated externally, one by 200 kilovolt λ rays and the other 3 with the 4 gram radium pack. Those treated with the radium pack had supplementary treatment by means of radium tubes inserted through the nares. One patient died in 1 month. 1 has been clinically well for 1 year 3 months, and the other has had palliation for 1 year 5 months. The patient who was treated with λ rays only, died in 6 months.

The 3 cases of lymphosarcoma of the nasopharynx occurred in 22, 24 and 26 year old males.

In the 22 year old male the disease was far advanced. Treatment consisted of surgical removal of the tumor from the orbit and nose and the patient died 10 months after admission from extension of the disease.

The 24 year old male was treated with 200 kilovolt λ rays and the insertion of a radium tube through the nares but he died from sarcomatosis in 9 months.

The third case the 26 year old patient, was treated with the 4 gram radium pack, following which there was complete disappearance of the lesion. Seven months later there was a recurrence which was treated with radium tubes inserted through the nares and 200 kilovolt λ rays to the right neck. Now 3 months later there is no evidence of the disease.

The alveolar sarcoma in the 18 year old male was treated with the radium pack but the man died 7 months after admission from local progression of the disease and sarcomatosis. The 9 year old male with a myxosarcoma was a very far advanced and hopeless case and was not treated. The 14 year old male with a myxosarcoma was treated by means of radon seeds and tubes and has been clinically well for 12 years.

It is remarkable to note that 53 per cent of the cases which involved the nasopharynx occurred in Italians.

SALIVARY GLAND

Of the tumors involving the salivary glands, totalling 16, 2 were outspoken malignancies, 1 was a spindle cell sarcoma and 1 a lymphosarcoma of the parotid gland. Fourteen of these tumors were of the mixed salivary type involving the parotid gland in 7 cases, submaxillary in 3 cases, inner cheek in 2 cases, inner upper lip in 1 case and the hard palate in 1 case. We have included the so called mixed salivary tumors because it has been our experience that these tumors do show

TABLE VII.—AGE AND SEX IN SALIVARY GLAND MALIGNANCIES

	Age															Sex	
	13	17	23	19	20		3	24	5	26	27	28	29	30	M	F	
Mixed salivary tumor															4	1	
Spindle cell sarcoma																	
Lymphosarcoma																	

malignant tendencies in that they recur extend, and even metastasize, causing death. This is shown in one of the cases reported here the tumor occurred in a 26 year old male recurred twice, and now shows metastases to the mediastinum and bones (fifth lumbar vertebra and tibia).

The symptoms in the cases of mixed tumor were gradual, painless swellings which had existed for from 3 weeks to 5 years before admission. Three patients noticed this swelling less than 6 months before seeking advice 4 between 1 and 2 years, 3 between 2 and 3 years, 1 for 3 years 1 for 4 years, and 2 for 5 years.

Eight of the 14 patients with mixed tumors had had surgical removal of the tumor before admission. One patient who had had no recurrence was not treated. Eight months after admission there was still no recurrence. In 4 of the patients there was a thickened scar at the time of admission 3 of them were treated with 200 kilovolt X rays and 1 with the 4 gram radium pack. These 4 have been clinically well without recurrence 1 for 5 years, 1 for 5 years 4 months, 1 for 4 years when she was lost trace of and 1 for 11 months since the time of admission. In 3 patients the disease had recurred following surgery. These also were treated with 200 kilovolt X rays. One was lost trace of in 1 month. In 1 the tumor remained stationary for 8 years when it was again removed surgically and the patient has been free from the disease for the past 5 years. In the third case, the tumor was held in check for 2 years 7 months when it began to grow. In spite of irradiation it has continued to grow and has metastasized to the mediastinum and bones (fifth lumbar vertebra and tibia).

One patient who had had biopsy before admission was treated with 200 kilovolt X

rays and died in 2 months. The disease was far advanced.

The 5 other cases of mixed tumor were treated in the following manner

An 11 year old female had biopsy followed by 200 kilovolt X ray treatment and the tumor has remained stationary for 4 years 3 months.

An 18 year old female was treated by radon seeds implanted into the lesion. This was improving when she died 2 months after admission from a chorionic epithelioma.

A 20 year old female treated with 200 kilovolt X rays and removal of the tumor and radium inserted into the wound, has been clinically well for 9 years.

A 26 year old female had biopsy and the tumor was treated with radium pack and only a thick scar has been present for 3 years.

The 30 year old male was treated with 200 kilovolt X rays and radon seeds. This lesion was on the hard palate was very far advanced at the time of admission and the man died 3 months later.

The patient with the spindle cell sarcoma in the parotid gland gave a history of being struck by a stone 4½ years before admission, following which he noticed a swelling in the parotid region. The growth was removed surgically treatment with 200 kilovolt X rays followed, and finally the lesion was coagulated. The tumor recurred after coagulation and caused death 6 months later.

The lymphosarcoma of the parotid in the 30 year old female had been removed 10 years before admission, recurred 2 years after removal, and grew gradually. This woman was treated with 200 kilovolt X rays and 4 years 8 months after admission died of a hemorrhage from the ulcerating lesion.

THYROID

There were 3 cases of malignancy of the thyroid (11) all the patients were females, aged 14, 24, and 30. Two of the tumors were carcinomata and 1 was an adenocarcinoma.

The 14 and 24 year old patients noticed a lump in the neck which grew gradually and caused coughing and choking spells. One had existed for 3 months and one for 4 months at the time of admission.

The 30 year old patient had had a goiter for 15 years which gradually became larger and for a few

TABLE VIII.—AGE AND SEX IN RESPIRATORY TRACT MALIGNANCIES

	Age												Sex	
	13	20	21	22	23	24	25	26	27	28	29	30	M	F
Epiglottis												1	1	
Larynx		1			1							1	2	1
Bronchus								1			1		2	
Lung						1							1	
Mediastinum			1	2						1	1		5	1
Pleura			1					1					1	1

months before admission she had had difficulty in swallowing and some pain.

Two had had thyroidectomy followed by irradiation and are alive and well for 1 year 6 months and 2 years 5 months, respectively.

The 14 year old patient had biopsy and treatment with the 4 gram radium pack but died in 3 months.

BRANCHIOGENIC TUMORS

There was 1 case of branchiogenic epithelioma in a 29 year old male who had noticed swelling of the nodes in the left side of his neck for 7 months. Biopsy was taken and he was treated with 200 kilovolt X rays on 2 occasions and he died 1 year 3 months after admission.

RESPIRATORY TRACT

The malignancies of the respiratory tract include 1 epithelioma of the epiglottis, 3 epitheliomata of the larynx 2 carcinomata of the bronchus, 1 lung carcinoma 1 endothelioma, 1 carcinoma and 4 tumors (not proved histologically) of the mediastinum, and 2 endotheliomata of the pleura. The ages and sex are shown in Table VIII

The patient with the epithelioma of the epiglottis complained of a sore throat for 2 months. Biopsy revealed an epithelioma. The lesion was implanted with radon seeds but the patient did not return after treatment, so the result is undetermined.

Portmann and Phillip in an article on cancer of the larynx in the young, review the literature and find only a score of cases. They say it is rare before the age of 30. Only 3 of 160, or 1.8 per cent of our cases, occurred in patients 30 years of age or younger

In the case of epithelioma intrinsic larynx in the 20 year old female, the patient complained of hoarseness for 2 years before admission. Treatment was

incomplete and the patient was lost from observation.

The 23 year old male was a switchman in a rail road yard. He gave a history of a chronic laryngitis of long standing due to irritation from soot. This patient was treated by laryngectomy followed by 200 kilovolt X rays. He has been clinically well for the past 6 years.

The 30 year old male complained of hoarseness for 15 months before admission followed by choking sensations. He was treated by tracheotomy and low power filtered X ray and died in 6 months.

The 2 carcinomata of the bronchus occurred in 29 and 26 year old males. One was not treated, the other died 3 days after admission and autopsy showed carcinoma of the bronchus with metastases to the liver and both adrenals

The 24 year old male with carcinoma of the lung was treated with the 4 gram radium pack but died 2 months after admission. Autopsy showed a large tumor in the lung and in the mediastinal and bronchial nodes, and metastases in the cervical lymph nodes. This patient had what he thought was a cold, with shortness of breath, a feeling of pressure in his chest, and difficulty in swallowing for 3 weeks before admission.

The 26 year old male with endothelioma of the pleura was admitted complaining of swelling of the nodes in the groin which were removed. The area was then irradiated. This man succumbed in 9 months from generalized metastases and autopsy showed a primary endothelioma of the pleura.

The 21 year old female with endothelioma of the pleura was treated with 200 kilovolt X rays and died in 5½ months. Autopsy showed a primary tumor of the parietal pleura on the right side with multiple extensions to mediastinal, abdominal and retroperitoneal lymph nodes to both kidneys, mesentery of intestines, and diaphragm.

The 22 year old male with endothelioma of the mediastinum had a biopsy of one of the cervical nodes. He was treated with radium packs but was lost trace of in 1 month.

TABLE IX.—AGE AND SEX IN GASTRO-INTESTINAL TRACT MALIGNANCIES

	Age												Sex	
	9	20		22	3	14	5	16	7	25	29	30	M	F
Stomach														
Sigmoid														
Rectum and anal canal							3				3	6		9

The carcinoma of the mediastinum occurred in a 21 year old male.

This patient died the day following admission and autopsy showed a tumor of the mediastinum, weighing 1,000 grams, the histology of which was carcinoma. The primary site was thought to be aberrant thyroid.

The 4 mediastinal tumors, not proved histologically occurred in patients 13 22 28 and 29 years of age respectively. Three were males 1 female.

The 13 year old male and the 28 year old female were not treated.

The 22 year old male had radium pack treatment but died in 1 month with no improvement.

The 29 year old male was treated with 200 kilovolt X rays following which his symptoms improved. The tumor remained stationary 4 years 3 months after admission.

GASTRO-INTESTINAL TRACT

There were 24 cases of malignancy of the gastro-intestinal tract: 2 carcinomata of the stomach, 3 adenocarcinomata of the sigmoid, 18 carcinomata of the rectum and 1 epithelioma of the anal canal. Table IX shows the ages and sex.

Both cases of carcinoma of the stomach were inoperable were treated with 200 kilovolt X rays and died in 4 months and 5 months respectively. Both of these patients complained of gastric distress which was chiefly the uncomfortable feeling of gas, 1 for 4 months and 1 for 1 year before admission. Ewing says of carcinoma of the stomach: "While the disease is distinctly one of advanced age, its rather frequent occurrence between 20 and 40 years, and even between 30 and 35 is noteworthy. Fowler reported 9 cases of carcinoma of the stomach before the age of 26 years."

Two of the patients suffering from adeno-

carcinoma of the sigmoid were operated upon and then irradiated the other was irradiated only. This latter patient died 2 weeks after admission and autopsy confirmed the diagnosis. The 29 year old female who had a positive Wassermann reaction died in 8 months but the 21 year old male is living and well for almost 2 years since admission.

Fowler (2) in reviewing carcinoma of the large bowel and rectum occurring in patients below the age of 26 calls attention to the seriousness of these lesions. No rectal case in his series survived one year. Cripps, quoted by Ewing found only 3 cases of carcinoma of the rectum between 20 and 30 years in a review of 380 rectal cancers. In our series there were 18 out of 634 cases.

Biopsies from 15 cases of carcinoma of the rectum showed gelatinous carcinoma in 3 cases adenocarcinoma in 10 and carcinoma in 2. Three very far advanced cases had no biopsy. Biopsy from the lesion in the anal canal showed squamous cell epithelioma with pearl formation.

Three of these patients had been operated upon for hemorrhoids before admission but the primary lesion was not discovered 2 had had colostomies performed. The chief complaints were pain, bloody and mucous discharge, constipation and diarrhea. The duration of these symptoms varied from 2 months to 2 years; most patients had symptoms for less than 8 months.

All the rectal lesions were far advanced at the time of admission. Three were not treated. The others were treated by radiation usually radon seeds implanted into the growth and supplemented externally with either radium packs or 200 kilovolt X rays. In a few cases external irradiation only was given. Eight patients died in less than 6 months, 2 in from 6 months to a year, 4 in from 1 to 1½ years.

TABLE V.—CARCINOMA BREAST
Primary Group I Cases (6 cases)

Age	Marital status	Lactation	Duration before admission	Treatment	Section	Result
1	S		1 mo.	Amputation and irradiation	Carcinoma	Died 8 months
15	S		3 yrs	Amputation and irradiation	Carcinoma	Clinically well 1 yr. no.
27	M	3 normal pregnancies 1 miscarriage	6 mo.	Amputation and irradiation	Carcinoma	Died 1 year 4 months
45	M	5 normal pregnancies (noticed lump while nursing child 5 mo. ago)	5 mo.	Amputation and irradiation	Carcinoma	Died 6 months
29	S		1 mo.	Amputation and irradiation	Carcinoma	Clinically well 3 years
30	M	1 normal pregnancy	5 mo.	Local excision and irradiation	Duct Carcinoma	Clinically well 1 year

Primary Group II Cases (4 cases)

24	S	3 months pregnant on admission	1 yr	Amputation and irradiation	Colloid carcinoma	Died 1 year 6 months
46	M	1 8 mo. pregnancy 3 miscarriages	3 mo.	Amputation and irradiation	Carcinoma	Died 6 months (patient 6 months pregnant at time of death)
27	S		1 yr 6 mo.	Amputation and irradiation	Carcinoma	Clinically well 4 yrs. Recurrence with widespread metastases. Lost 3 yrs 4 mo. after admission
28	M	2 normal pregnancies	1 yr	Amputation and irradiation	Carcinoma	Died 1 yr

*1 year

Primary Group III Cases (4 cases)

29	M	5 normal pregnancies (none of last pregnancy 3 yrs. ago breast painful and swollen)	1 yr 9 mo.	Irradiation only	Adeno-carcinoma	Lost trace of 1 yr 2 mo.
29 1/2	M	3 normal pregnancies	3 weeks	Not treated	None	Not treated
30	M	4 miscarriages	8 months	Irradiation only	None	Died 3 months
30	M	2 normal pregnancies	7 months	Amputation and irradiation	Carcinoma	Died 1 yr 2 mo.

15 1/2 or 16 years ago

and 1 patient is living 3 years 6 months after admission and is having palliation

The epithelioma of the anal canal occurred in a 24 year old female and was far advanced when the patient was admitted. This was treated with 200 kilovolt X rays and the woman died 1 year 5 months after admission.

The 1 case of carcinoma of the mesenteric nodes occurred in a male, aged 28 years. The primary site was not found in this case and the patient died in 2 weeks. The lesion was revealed by exploratory laparotomy.

BREAST

Twenty five patients with breast carcinoma were 30 years of age or younger. This is 13 per cent of the total number of breast car-

cinomata admitted to this institute. Of these 25 14 were primary tumors and 11 were recurrences after operation.

Ewing says, "Before 30 years of age mammary cancer is extremely fatal so that some surgeons prefer not to operate during this period. Schwartzoff reports 15 such cases, all rapidly fatal in spite of early operation." Lee is strongly of the opinion that cancer of the breast in young women is a much more menacing disease than it is in middle life or old age. Of 51 of his cases in patients under the age of 30 years 30 were treated by radical operation and only 17 per cent survived 3 years. Stout also is of the opinion that "cancer free survivals are decidedly fewer below the age of 35." Matthews, on the other hand,

TABLE XI—CARCINOMA BREAST
Postoperative Recurrent Cases (11 cases)

Age	Marital status	Lactation	Deaths before admission	Length of time since operation	Duration of recurrence	Section	Result
26	S		4 yrs 6 mo	4 yrs.	2 yrs.		Died 6 yrs 9 mo from adenoma (good palpation from axilla)
26	M.	normal pregnancy	1 yr	4 mo	3 mo.	Carcinoma	Died 1 yr. 3 mo
26	M	normal pregnancy mastectomy		mo	6 wks.	Carcinoma	Died 11 mo.
26	M	normal pregnancy	17 10 mo	17 7 mo	3 mo.	Carcinoma	Died 6 mo
26*	S		5 yrs	3 mo	10 mo.	Colloid Carcinoma	Chemically well year—recurrence Died 4 yrs. 9 mo after admission
26	S		1 yr 4 mo	1 yr	2 yrs.	Scirrhous carcinoma	Died 2 mo
29	S		2 yrs.	17 mo	2 mo 2 wks	Carcinoma	Died 3 mo
30	M	normal pregnancy	5 mo	mo			Died 8 mo
30	M	4 normal pregnancies	3 mo				Not treated
30	M	3 normal pregnancies	17	5 mo			Died 4 mo
30	M		17 6 mo	17 6 mo	3 mo		Died 17 mo

NOTE.—All deaths were due to widespread metastases in axilla.

in reviewing the 10 year survivals of mastectomy says. The younger patients, contrary to common belief do quite as well following operation as the average patients.

According to Deaver and McFarland 13 per cent of all tumors of the breast before the age of 30 are cancer. They quote Rodman as saying that 9 per cent of all tumors of the breast before the age of 30 are malignant and also speak of the poor prognosis of cancer of the breast in women under the age of 35.

It has been our experience that malignancy of the breast in young women is more virulent especially if complicated with pregnancy or lactation.

Table A shows the ages, marital station, lactation history of injury treatment, section and results of treatment of our 25 cases. The Group I cases are those in which the tumor was confined to the breast. Group II, with metastases in the axilla or ulceration of the skin. Group III tumor in the breast which is fixed to the chest wall or ulcerating with wide spread metastases. All the postoperative, recurrent cases in Group III, had widespread metastases at the time of admission.

FEMALE GENERATIVE ORGANS

The gynecological malignancies have been reported in detail by the authors (13)

There were 115 patients 30 years of age or younger suffering from malignancy of the female generative organs 78 epitheliomata of the cervix, 1 adenocarcinoma of the cervical canal 1 adenocarcinoma and epithelioma of the cervical canal 23 malignant tumors of the ovary 1 adenocarcinoma of the fundus of the uterus 2 malignant leiomyomata of the uterus, 3 chorionic epitheliomata of the uterus, 3 epitheliomata of the vagina, 1 botryoid sarcoma of the vagina 3 epitheliomata of the vulva.

Table XII shows the ages and marital status of the patients in this group.

If seen early there is a good possibility of eradicating epithelioma of the cervix. The recognition of the disease in its early stage, especially in young women, is important, as it may be the means of saving the life of a young mother so needed for her children's sake. It will be found that cancer prevention in this particular group lies within the grasp of the family physician, who should acquaint himself with evidences of cervicitis, ulcerations, erosions, and leucoplakic areas on the cervix so that he may advise proper treatment for these precursors of malignancy. Abnormal discharges in young women are indications of pathological conditions. Blood as a symptom must be looked upon as accidental—yellow

TABLE VII.—FEMALE GENERATIVE ORGAN MALIGNANCIES

	Age																				Mortality status	
	8	11	14	15	17	18	19	20	21	22	23	24	25	26	27	28	29	30			E.	M.
Epithelioma cervix						1		1		2	4	7	8	8	9	13	11	19		1	17	
Adenocarcinoma cervical canal															1							1
Adenocarcinoma and epithelioma cervical canal																	1					1
Malignant tumors ovary			1	1	1			1			1	1	1		1	1	1	1	1	1	1	10
Adenocarcinoma fundus uteri																		1				1
Malignant leiomyoma uterus												1										1
Chorioid epithelioma uterus						1													1	1	1	1
Epithelioma vagina																	1	1				1
Sarcoma, botryoid, vagina	1																				1	
Epithelioma vulva													1						1	1	1	1

ish, watery, or foul smelling discharge usually precedes the showing of blood, which does not occur until the tumor begins to ulcerate and break down. Our only hope of discovering and treating early lesions of the cervix lies in careful gynecological examination bimanually and with a speculum resorting to biopsy and cauterization in the so called cervicitis and erosion to rule out or discover early malignancy.

Cervical cancer in young women here reported in Groups I and II (Schmitz) have yielded healings in about the same proportion as the general average in cancer of the cervix, namely 50 and 33 per cent. Groups III and IV have been only palliative. All treatment has been by 200 kilovolt X rays externally and radon seeds and radium tubes intra uterine.

Only 1 patient in this group under 30 suffering from epithelioma of the cervix, was unmarried. The 77 others had from 1 to 8 pregnancies, bearing out the theory that trauma and inflammatory lesions have a great influence in the production of malignancy of the cervix.

The only hope in the treatment of ovarian malignancy lies in the early recognition of the disease, and its early treatment by operation and irradiation. The 23 malignant tumors of the ovary include 6 papillary cyst adenocarcinomata, 6 adenocarcinomata, 9 carcinomata, 1 sarcoma, and 1 malignant teratoma. Thirteen of these patients were single, and 10 were married.

Of the 23 cases, only 2 were not proved pathologically, 1 had no operation and the other had had a laparotomy but no section was taken. The majority of these patients had been operated upon before admission. One patient was not treated, the others received either 200 kilovolt X rays or 4 gram radium pack treatment. Six of the patients have lived from 5 months to 8 years after treatment and have been free from the disease for 5 months 6 months, 2 years 2 months, 2 years 8 months, 2 years 10 months and 4 years respectively. This latter patient is alive 8 years since the time of admission but suffered a recurrence 4 years 4 months after original treatment and then was operated on and treated again. Three others are living but are not free from the disease, 2 for over a year with some palliation, and 1 for 2 months unimproved. Three were lost trace of and the 10 others died, 7 in less than a year, 2 in 1 to 2 years, and 1 in 5 years 11 months.

The case of adenocarcinoma of the uterus in a 30 year old patient, was treated with intra uterine radium application and 200 kilovolt X rays over the pelvis. The patient was lost trace of 1 month after treatment.

There were 2 cases of malignant leiomyomata.

One occurred in a patient aged 24, married, whose menstrual periods from the age of 14 were regular but rather profuse, lasting from 7 to 8 days. She had had one miscarriage but no other pregnancies. Seven weeks before admission menstrual periods

TABLE XIII—AGE AND SEX—KIDNEY MALIGNANCIES

	Age							Sex	
	20 yrs.	30.	40.	50.	60.	70.	80.	M	F
Adenocarcinoma									
Mixed tumor									
Embryonal adenocarcinoma									

became longer and harder. Hysterectomy was performed for a supposed fibroid uterus. Pathological examination showed this tumor to be a malignant leiomyoma. This patient received 200-kilovolt X-ray treatments 1 month following operation and was alive without recurrence 5 years and months after treatment when last examined.

The other case occurred in a patient aged 24 years married with 6 children.

This woman had given birth to a child 6 months previous to admission, following which she had a 6 day hemorrhage. Four months after the birth of the child, a hysterectomy was performed for a malignant leiomyoma. At the time of admission there was a recurrence in the vault of the vagina extending into the broad ligament areas. She was treated by radium applications but the lesions progressed and she died without any palliation 9 months later. Autopsy showed recurrence in the pelvis and generalized metastases.

One case of chorionic epithelioma was observed in a patient aged 30 years married a mother of two children aged 8 and 5 years.

Her menstrual periods from the age of 12 were always irregular. At the age of 20, she began to have a yellowish discharge, and for 3 months previous to admission she had continual bleeding following a miscarriage. A pan-hysterectomy was performed and sections from the body of the uterus showed the presence of a chorionic epithelioma. Postoperative irradiation was given and this patient is alive and well 14 years after admission.

The second case of chorionic epithelioma, occurring in an 18 year old female was found at autopsy.

This patient had been treated at the institute for a salivary tumor inner right cheek, was single and gave no history of menstrual disturbance or pregnancy. She was operated on for a "ruptured ovarian cyst" 2 months before admission.

Three cases of epithelioma of the vagina were observed in patients aged 30, and one in a patient aged 28.

One patient, aged 30, gave a history of bearing down pain for 7 months, last menstrual period 3 months previous to admission. She was 3 months pregnant at the time her family physician excised a growth, section of which showed it to be an epithelioma. There was a recurrence of this lesion within a month. Upon admission, the recurring tumor was implanted with gold seeds of radon, following which there was a prompt regression of the tumor. The pregnancy proceeded uninterrupted to full term when a healthy child was born. On last examination, there was no evidence of recurrence, 14 months after treatment.

This case typifies the necessity of prompt and accurate treatment which in this case was successfully performed and was not only the means of saving the life of a mother up to the present time but also the life of a child, conceived before radiation treatment.

One was in a syphilitic, aged 28, who gave a history of continuous bloody discharge only over a period of 3 months. The lesion was far advanced and involved the anterior and lateral walls of the vagina. She was treated by irradiation, which proved of little benefit, and she succumbed to the disease 9 months after admission.

The other also was a far advanced case.

This patient's periods were irregular occurring every 2 weeks and she complained of a yellowish discharge between her supposed menstrual periods. At the time of examination there was a large infiltrating growth involving the posterior wall of the vagina and extending into the posterior fornix. She was treated by irradiation but succumbed to the disease in 2 months.

The botryoid sarcoma of the vagina occurred in a child 2 years of age.

About six months prior to admission the mother had noticed a swelling in the lower abdomen but the child complained of no pain. Following this a growth was found protruding from the vagina and involving the vulva. Part of the growth was removed by her family physician. At the time of examination at the institute, there was a tumor mass in the lower abdomen extending to the umbilicus and a purulent dis-

charge from the vagina. There was a fungating tumor mass involving the vagina and vulva. Sections from this growth showed it to be myxofibrosarcoma, or sarcoma botryoid. The child died of the disease 4 months after irradiation was administered and 10 months from the beginning of symptoms.

Ewing says "Rhabdomyoma uteri appears almost exclusively as an element in the polypoid vaginal sarcoma of children and adults (sarcoma, botryoid, Pfannenstiel). This process affects the vagina in children and chiefly the cervix in adults (Gow and Pick). The symptoms are hemorrhage, fetid discharge, and a protrusion of a polypoid tumor from the vagina, with dysuria, pain, fever and cachexia. The vagina is eventually filled with ulcerating masses and there are bulky extensions into the pelvis. The usual histology is that of a large spindle-cell sarcoma with many blood and lymph vessels, myxomatous tendencies and areas of striated muscle."

Three cases of epithelioma of the vulva were observed, one in a patient aged 25, and 2 in patients aged 30.

The patient aged 25 was single and gave a history of having a small nodule which occurred in theitoris 1 year prior to admission. At the time of examination there was an exceedingly painful, ulcerating tumor about 3 centimeters in diameter which involved the region of theitoris and there were palpable inguinal and femoral nodes. The lesion was treated by irradiation with temporary improvement. During the course of one year the disease progressed and she finally succumbed to extensive involvement of the whole vulva and inguinal lymph nodes.

In this particular case the use of strong douches of bichloride of mercury may have been an etiological factor.

One of the patients, aged 30, was married. Ten months before admission she noticed a small sore on the labia. She consulted a physician who told her it was an ingrown hair and removed it. As she did not get any relief she consulted another physician but with no better results. Later as she was 5 months pregnant, she went to still another physician who told her the sore would probably improve after childbirth. At the time of admission to the institute the baby was 8 weeks old and the soreness had increased. Examination showed an ulcerating infiltrating epithelioma involving the whole vulva and clitoris region and large metastatic nodes in both groins. Irradiation in this case was of little or no avail and she died in 4 months.

Here, included in this history, is evidence of neglect on the part of the physician to render prompt and efficient treatment.

The other patient, aged 30 years, was single. The lesion had recurred after operation and was far advanced at the time of admission. It was ulcerated and involved the whole vulva. The treatment was irradiation for palliative effect but she died in 6 months.

GENITO-URINARY TRACT

There were 36 malignancies of the genito-urinary tract in patients under 30 years of age. Three adenosarcomata, 4 mixed tumors and 1 embryonal adenocarcinoma of the kidney, 1 congenital sarcoma of the adrenal, 3 epitheliomata of the penis, 24 malignant teratomata of the testicle.

The kidney tumors were all treated with external irradiation either radium packs or 200 kilovolt X rays. Four of these cases had had removal of the kidney before admission and 1 an exploratory operation in which the tumor was too far advanced for removal. All patients except the one suffering from the embryonal adenocarcinoma died in less than 2 months from the time of admission. This patient lived for 1 year 2 months but succumbed from progression of the disease at that time.

Table XIII shows the ages and sex of the patients with kidney malignancies under the age of 30.

The congenital sarcoma of the adrenal occurred in a 2½ year old male and was treated with 200 kilovolt X rays. He died in 2 months and autopsy showed metastases to the liver and lungs.

Malignant tumors of the testicle represent about 0.05 per cent of the total number of malignancies admitted to the institute. Twenty-four of these occurred at the age of 30 or younger or 43 per cent of the total number of testicular tumors. All of these cases were regarded as malignant teratomata which were divided as follows: 4 adult type, 12 solid embryonal carcinomata, 1 embryonal carcinoma with lymphoid stroma, 6 embryonal adenocarcinomata, and 1 unclassified (no section).

Table XIV shows the ages at which the testicular tumors of different types occurred.

TABLE XIV—AGE INCIDENCE—TUMORS OF TESTIS

Age	10 mos	1 yr	2	3	4	5	6	7	8	9	10
Adult type											
Solid embryonal carcinoma (teratoma)								3			
Embryonal carcinoma with lymphoid stroma											
Embryonal adenocarcinoma											1
No section											

One adult type teratoma occurred in a child 10 months of age. It was treated surgically, the testicle being removed, followed by treatment with 200 kilovolt X rays over the lymph bearing areas in the groin and abdomen. This patient is alive and well 9 years after treatment.

The 3 others in this group had widespread metastases at the time of admission and were treated surgically by removal of the testicle and cord followed by 200 kilovolt X rays. Two died in 2 months each, and the other has been having palliation for 6 months.

Eleven of the 12 cases of solid embryonal carcinoma (seminomata) had widespread metastases at the time of admission. Six of them had metastases to the lungs as well as retroperitoneal nodes. All were treated by removal of the primary tumor and radiation radium packs in 5 cases, and 200 kilovolt X rays in 7 cases. One patient survived 4 years 9 months after which he succumbed to the disease. The others all have died: 1 in 2 years (this is the one without metastases at the time of admission), 1 in 1 year 1 month, 1 in 1 year 8 in less than a year.

The patient with the embryonal carcinoma with lymphoid stroma had metastases in the abdominal nodes and liver at the time of admission. He was treated by removal of the testicle and 200 kilovolt X-rays and is alive and well 1 year 4 months after admission.

The 6 patients with embryonal adenocarcinoma were treated by removal of the testicle followed by 200 kilovolt X rays in 5 cases and radium packs in 1 case. Only one patient was free from metastases at the time of admission. He is alive and well 4 years since admission. All the others had widespread metastases, 4 having metastases into the lungs and mediastinum. These died: 1 in 1 year 5 months, 4 in 2 to 4 months.

The symptoms given in the histories were pain in 3 cases, swelling in 10 cases, swelling and pain in 5 cases, swelling and pain following injury in 6 cases. The duration of these symptoms was from 2 weeks to 6 years. The majority of patients had symptoms for less

than a year. 11 gave a history of duration for less than 6 months, 9 for less than a year. From the authors' point of view it is very difficult to evaluate the history of trauma as an etiological factor.

Most authorities are agreed on the statistical fact that malignant tumors of the testicle are very virulent. Stout says, "In general it may be said that testicular cancers are prone to be exceedingly malignant and fatal." Himman collected 100 cases treated by radical operations, 17 per cent of which are alive at the end of 5 years.

The analysis of testicular tumors in this paper has to do only with those tumors which occurred in patients 30 years of age or younger. In all the testicular tumors admitted to the state institute the ages ranged from 10 months to 49 years. The disease occurring in patients 30 years of age or younger seems to be more virulent than after the age of 30.

Herger and Thibaudau, in studying all the cases of malignant teratoma of the testes admitted to the institute, 55 proved cases, find 36 cases available for 3 year statistics, of which 13 or 36 per cent have survived 3 years or longer; 21 cases available for 5 year statistics of which 7 or 33.3 per cent, have survived 5 years or longer. They conclude that the embryonal carcinoma with lymphoid structure seems to have the better prognosis.

Epitheliomata of the penis occurred in 20, 18 and 29 year old patients. Two of these lesions were of the papillary type.

The 20 year old patient had a positive Wassermann reaction and gave a history of having noticed a pimple on the glans which gradually grew larger. Upon admission to the institute he was treated by radical operation and low power X-ray. He was clinically well for 7 years and then was lost trace of.

The 29 year old patient had an operation 19 months before admission for phimosis. The incision healed with a warty growth which became ulcerated.

He was treated by amputation of the penis and low power X ray and has been clinically well for 12 years 8 months.

The 28 year old patient was admitted 6 months after he noticed a lump in the groin. This metastatic growth in the groin had been removed and he was circumcised before admission. Upon admission he was treated with 200 kilovolt X rays. He died in 3 months.

MISCELLANEOUS

There was 1 case of carcinoma in the sacral region in a 30 year old female. Although biopsy showed carcinoma, we believe this may have been a malignant teratoma. Four months before admission this patient noticed severe pain and swelling of the hip. She was treated with the radium pack and died 5 months after admission from progression of the disease.

Another case, in a 30 year old male was an adenocarcinoma of the left scapula. The growth had been removed at the time of admission, he was treated with 200 kilovolt X rays, did not improve, and was lost trace of in 3 months.

Another was a metastatic carcinoma of the neck in a 29 year old male. The primary source was not ascertained. He was treated with 200 kilovolt X rays and died in 3 months.

There were 6 cases of endothelioma, 3 in the lymph nodes in the neck, 2 in the thigh with metastases in the groin, and 1 in the soft tissues over the hip in 7, 12, 14, 15, 21 and 29 year old patients, 2 males, 4 females. All had histological sections, were treated with 200 kilovolt X rays and died in from 5 to 9 months from the time of admission from generalized metastases.

BONE

There were 48 primary bone sarcomata in patients under 30 years of age, 36 osteogenic sarcomata (including 1 sclerosing type, 2 peritheliomata, 1 myxofibrosarcoma), 3 osteochondrosarcomata, 3 chondrosarcomata, 1 hereditary deforming chondrodysplasia with secondary chondrosarcoma of the femur, 5 Ewing sarcomata.

The 36 osteogenic sarcomata involved the upper extremities in 9 patients (8 humerus, 1 forearm), the axilla in 1 patient, the lower extremities in 19 patients (12 femur, 4 tibia, 1 fibula and 2 foot), the ischium in 1 patient,

the ilium in 1 patient, the supra-orbital ridge in 1 patient, and the lower jaw in 4 patients. All of these tumors were far advanced on admission, 6 patients having metastases in the lungs in addition.

In 6 cases the extremity was amputated and treated by irradiation, either 200 kilovolt X rays or radium packs. Four of these patients died, 1 in 9 months, 1 in 1 year, 1 in 1 year 3 months, and 1 in 2 years, from metastases to the lungs, no recurrence on the stump.

One patient was lost trace of in 1 year 6 months at which time he wrote he was feeling well, the other died 11 months after amputation from pulmonary tuberculosis, no recurrence of the malignancy at the time of death.

In one case the tumor was removed from the right tibia followed by irradiation and this patient is now clinically well 1 year 6 months since admission.

Sixteen other cases in which the tumor involved the extremity were treated by irradiation only. Thirteen died in less than a year and 3 died in from 1 to 2 years.

In 1 case the tumor in the os calcis was removed surgically and then treated by radiation. The growth was arrested for 4 years when a bluish-looking tumor developed in the scar over the skin of the foot where it was irritated by the patient's shoe. This grew with a sudden rapidity necessitating amputation of the leg. Patient was 6 months pregnant at the time of amputation and a normal child was born 5 months before her death from general metastases to the lungs and viscera 8 years 5 months after admission.

The sclerosing osteogenic sarcoma of the humerus which was treated by irradiation only has been arrested for 3 years.

One of the peritheliomata occurred in the fibula, was treated by means of the radium pack and then the leg was amputated elsewhere. The patient died 2 weeks after amputation.

The perithelioma in the femur was treated with 200 kilovolt X rays and the patient died 9 months after admission from progression of the lesion and metastases to the lungs.

The tumor in the axilla was removed surgically and histologically showed osteogenic sarcoma. The patient was then subjected to irradiation and has been clinically well for 2 years 4 months. This was a case of osteosarcoma in soft tissue but with no involvement of bone.

The osteogenic sarcoma of the ischium had metastasized to the lungs and pelvis at the time of admission. This was treated with irradiation but the patient died in 1 month.

The tumor in the ilium also was treated by irradiation and is now progressing 8 months after admission.

The sarcoma in the supra-orbital ridge was incised and some of the tumor tissue removed. It was then

TABLE XV—AGE AND SEX INCIDENCE IN BONE MALIGNANCIES

	Age																				Sex	
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	M	F
Osteogenic sarcoma																					1	0
Scroving osteogenic sarcoma																						
Myelofibrosarcoma																						
Pariosteoma																						
Osteochondrosarcoma																						
Chondrosarcoma																						
Hereditary deforming chondrodysplasia with secondary chondrosarcoma																						
Ewing sarcoma																					1	

treated by irradiation but the tumor progressed and the patient died in 1 year 11 months.

Two of the jaw tumors were treated by irradiation only. 1 patient died in 3 months and 1 in 5 months. One patient is living for 6 years with arrest of the tumor following biopsy and irradiation. One tumor was excised and the patient then subjected to irradiation. This patient died in 7 months.

The symptoms in these cases were pain and swelling. Twenty-two patients gave a history of injury as the beginning of their illness. 8 fell striking the diseased part, 7 gave a history of muscle strain, 6 a blow, and 1 of being burned by the explosion of fire-works.

One of the osteochondrosarcomata occurred in the humerus. This was treated by irradiation. The tumor process had apparently been arrested but was still present at the time of death from other causes 5 years 8 months after admission.

The second osteochondrosarcoma occurred in the femur. This was treated by irradiation and the patient died in 3 months.

The third tumor occurred in the sacrum. The tumor was removed and then the patient was irradiated, and died in 9 months. There was a history of injury in 1 case.

The three chondrosarcomata occurred in the sacroiliac region, sixth rib and the tibia. All were treated with 200 kilovolt X-rays and died in 3 months, 5 months, and 8 months respectively. There was a history of injury in 2 cases.

The hereditary deforming chondrodysplasia with the secondary chondrosarcoma of the femur occurred in an 18 year old boy. This was treated by irradiation and amputation of the femur was advised but refused. The lesion is rapidly progressing now 1 year 8 months after admission.

The five Ewing sarcomata occurred in 7, 11, 12, 14, and 15 year old children. 3 in the tibia, 1 in the femur and 1 in the ischium. Four

of them had a history of injury at the site of the tumor.

One patient with a tumor in the tibia had the tumor removed by curettage and was then treated with 200 kilovolt X-rays. This child was clinically well for 2 years 11 months when there was a recurrence and she died 3 years 4 months after admission from generalized metastases.

Another patient with a lesion in the tibia was treated with irradiation and then the leg was amputated. He lived 2 years 2 months when he died from lung metastases.

The third patient with the tumor involving the tibia died in 3 months. He also was treated with 200 kilovolt X-rays.

The patient with the tumor in the femur died months after admission. There was some local improvement following X-ray treatment.

The fifth case, with the tumor in the ischium, is still alive 1 year 7 months after admission and has shown some local improvement following 200 kilovolt X-ray treatment.

MISCELLANEOUS SARCOMATA

There were 72 cases of miscellaneous sarcomata, not included in any of the foregoing groups of cases reported in this paper. Twenty-six were lymphosarcomata, 4 wherein the biopsy showed lymphosarcoma but the blood pictures were that of aleucemic leukemia, 4 angiosarcomata, 2 mixed cell sarcomata, 6 fibrosarcomata, 3 myxofibrosarcomata, 15 spindle cell sarcomata, 8 neurofibrosarcomata, and 4 unclassified sarcomata, as follows:

There were 26 cases of lymphosarcoma in patients under 30 years of age: 18 males and 8 females.

Nearly all of these patients gave the history of a painless swelling; only 2 gave the history

of any pain as the beginning of their illness. In 17 cases the duration was less than 6 months, in 7 cases for 1 year each, and 2 cases for 3 years each. All of these growths developed rapidly. Twelve were noticed first in the neck, 1 in the parietal region, 2 over the scapula, 1 in the axilla, 1 in the forearm, 4 in the abdominal nodes, and 5 were lymphosarcomatous primary source unknown. With one exception—a leucocyte count of 26,600—the original leucocyte counts varied from 7,000 to 18,900. In only 4 instances did the percentage of lymphocytes exceed 30.

One case in this group was not treated. The others were treated by 200 kilovolt X rays in 23 cases and radium packs in 2 cases. In all of them there was marked regression of the tumors immediately following treatment but 23 patients died from progressive anemia and general lymphosarcomatosis, 1 in 1 month, 6 in 2 months, 5 in 3 months, 5 in 4 months, 1 in 5 months, 1 in 6 months, 1 in 10 months, 2 in 1 year, and 1 in 2 years, 6 months. One patient is living for 7 months since treatment and another is living for 3 years 7 months but is still undergoing treatment from time to time.

There were 4 cases in which the biopsy showed lymphosarcoma but the blood pictures in all assumed that of an aleucemic leukemia, the lymphocytes varying from 52 to 76 per cent.

The disease occurred in a 23 year old female who died in 4 weeks following 200 kilovolt X rays, a 13 year old male who also died 2 weeks after admission, an 11 year old male who is living 7 years after admission who was irradiated and is well 5 years since last treatment, and a 23 year old male who is living 5 years after admission and is clinically well for 1 year since last treatment.

There were 4 cases of angiosarcoma

One occurred on the cheek of a 5 year old female. This was removed surgically and treated prophylactically with a large amount of radon lightly filtered, and the patient has remained clinically well for 11 years.

The next case of angiosarcoma occurred in an 11 year old female. This child's trouble began with abscesses on the vulva following an injury in the gymnasium after which a mass developed in the pelvis. Upon admission she had a generalized sarcomatosis. She was treated with 200 kilovolt X rays

following which there was relief of pain and she gained some strength for a time. She died 8 months after admission and autopsy showed angiosarcoma involving the pelvis, lungs, ribs, bronchial glands, scalp, extradural space, brain, and tissues about the spine.

The third case occurred in a 25 year old male in the tissue over the right scapular region. Following 200 kilovolt X rays over this area the tumor disappeared but the patient developed lung metastases and died 4 months after admission.

The fourth case occurred over the ankle in a 21 year old female. She was treated with radium packs with marked regression of the tumor. She was delivered of a normal child 10 months after admission. During the latter months of her pregnancy and following her delivery she was unable to report for observation or treatment. The lesion progressed and the leg was amputated at another hospital. Five months later there are numerous and widespread metastases and patient is moribund.

Three of these patients gave a history of injury as the beginning of their illness.

There were 2 cases of mixed cell sarcoma, 1 on the foot of a 24 year old male and one in the thigh of a 30 year old female.

The lesion in the 24 year old male had existed 5 years previous to admission, appearing as a swelling which followed an injury caused by dropping a sharp plank on his foot. This swelling grew gradually until 9 months before admission to the institute, after which it grew rapidly. It was excised 1 week before admission. The scar was treated with low power filtered X ray and appeared clinically well for 1 year 10 months when there was a recurrence. Three years after admission lung metastases developed and the patient died; the lesion on the foot was not healed at the time of death.

The lesion in the 30 year old female began as a hard lump on the thigh $1\frac{1}{2}$ years before admission. This remained stationary for 2 years after which it began to grow rapidly. The growth had been removed about 3 weeks before admission. Upon admission, the incision was nearly healed and she was treated prophylactically with 200 kilovolt X rays. There has been no recurrence up to the present time, years 5 months after admission.

There were 6 cases of fibrosarcoma. These lesions occurred 1 on the top of the head, 1 over the eyebrow, 1 at the angle of the jaw, involving the bone, 1 over the shoulder, 1 in the thigh, and 1 in the abdominal wall. Two of these patients gave a history of injury as the beginning of their present illness. In all the cases the tumors were removed and treated with 200 kilovolt X rays. Three of

TABLE XVI—AGE AND SEX INCIDENCE—SARCOMA EXCLUSIVE OF BONE SARCOMA

	Age																										Sex			
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	M	F
Lymphosarcoma																													18	3
Lymphosarcoma with abnormal blood picture																													3	
Angiosarcoma																														
Mixed cell																														
Fibrosarcoma																														
Myxofibrosarcoma																														
Round cell																														
Neurofibrosarcoma																														
Unclassified																														

the patients are clinically well since treatment 1 for 5 years 1 for 1 year and 1 for 7 months.

In 1 case the tumor has remained stationary since the time of admission, 1 year 2 months. The patient with the skull lesion died in 3½ months and autopsy showed fibrosarcoma involving the dura mater.

The patient in which the jaw bone was involved died 1 year 3 months after admission from progression of the disease.

There were 4 cases of *myxofibrosarcoma*. Two of these patients gave a history of injury as the beginning of their trouble.

One of these lesions occurred in the ischioanal space of a 17 months old female. The tumor was removed and treated with radium. She has been clinically well for 3 years without recurrence. One occurred over the sacrum of a 6 year old female, was removed surgically and treated with 300 kilovolt X rays and has been clinically well for 4 months following last treatment. It is now 7 months since admission.

The third occurred in a 20 year old female, at the knee. This was treated with the radium packs with no improvement. The leg was amputated elsewhere and the patient died 8 months after admission to our hospital from metastases into the chest.

The fourth case was in the arm of a 20 year old female. This patient also had a carcinoma of the left breast which is reported in this paper with the breast lesions. The breast lesion was treated at our institution but at the time of admission, the arm had been amputated by shoulder girdle amputation. Sections of the lesion showed no bone formation. There has been no recurrence of the sarcoma for 10 years.

There were 15 cases of *spindle cell sarcoma* 1 of the jaw 1 mastoid region 1 frontal region

3 arm 2 axilla, 2 shoulder 4 lumbar region and 1 foot. Five patients gave a history of injury as the beginning of their present illness. One patient was not treated. The others were treated by the removal of the tumor followed by irradiation either 200 kilovolt X rays or radium packs. Eight of the patients died from the disease 6 in less than a year 1 in 12 years, and 1 in over 6 years.

The patient who died 12 years after admission was clinically well for 9 years when there was a recurrence which responded to further treatment and the local lesion was well at the time of death from liver and lung metastases.

The patient who died 6 years 2 months after admission died from metastases to the lungs and axilla, the lesion in the arm did not recur and had been clinically well for 4 years 4 months before death from metastases. Five of the patients are clinically well 2 for 14 years, 2 for 5 years, and 1 for 1 year. The other patient has been having palliation since admission, 8 months ago.

There were 8 cases of *neurofibrosarcoma*. Three of the patients gave a history of injury at the site of the lesion previous to noticing the lesion. In 7 of the cases, the tumor was removed and irradiation treatment either 200 kilovolt X rays or radium pack, was given.

In 1 case irradiation only was given by means of 200 kilovolt X rays. This patient died 10 months after admission from rapid extension of the lesion throughout the abdomen.

The others have been clinically well 1 for 10 years 1 for 3 years, 2 for over 5 years, 2 for over 1 year and 1 has been receiving treatment over a period of 4 years. There is no progression of the disease in the latter case but nodules are still present.

There were 3 cases of *unclassified sarcoma*

One occurred in a 10 month old female following injury. The tumor involved the left temporal region and orbit, was hard and seemed attached to the bone but X ray plates showed no destruction of bone. Section was taken but this tumor could not be definitely classified. Treatment was by means of 200 kilovolt X rays. She died 2 years 3 months after admission from *sarcomatosis*.

One occurred in the soft tissues of the hand of a 15 year old girl and the metacarpal bones were involved secondarily. Treatment was by means of the radium packs. Marked regression of the tumor followed. Sixteen months after admission, the patient died from mediastinal and lung metastases.

The third case occurred in the right thigh of a 22 year old female. This tumor was removed surgically and then treated with 200 kilovolt X rays. It is now 5 months since admission and there is no recurrence since treatment.

Table XVI shows the ages and sex of the sarcomata, excluding the bone sarcomata

HODGKIN'S DISEASE

The total number of cases of Hodgkin's disease admitted to the institute up to October 1, 1933 was 137, 64 of these were in patients 30 years of age or younger as shown in Table XVII, 39 males and 25 females.

Hodgkin's disease is a disease of the reticulo-endothelial system which is looked upon by some authorities as an infectious granuloma and by others at least at times as of distinct neoplastic origin namely Hodgkin's sarcoma (Ewing). Hodgkin's disease may occur at any age, 47 per cent of our cases occurred before the age of 30. It is characterized by a large variety of symptoms. Zeigler, as quoted by Ewing, recognized an acute or chronic form. The duration varies from a few weeks in acute cases to many years, but is usually about 18 months. In this disease the origin may be in the lymph nodes anywhere in the body but frequently in the beginning involves the cervical, axillary inguinal, mediastinal or abdominal nodes. Eventually most cases show a generalized involvement, progressive anaemia, chlorotic type or even sometimes assuming a pernicious type. In our experience blood examinations showed loss of haemoglobin and red blood cells the leucocytes varied from 2,500 to 128,000 but, contrary to some authors, lymphocytosis or eosinophilia

TABLE XVII.—HODGKIN'S DISEASE

Ages	Cases	Ages	Cases
5	3	18	3
6	0	19	3
7	1	20	3
8	2	21	1
9	1	22	2
10	0	23	8
11	0	24	6
12	0	25	4
13	2	26	6
14	1	27	3
15	1	28	5
16	0	29	4
17	2	30	3

was rarely observed. An intense pruritus is frequently associated with Hodgkin's disease early as well as late. Fever may be present early but is usually associated with the terminal stages.

From the diagnostic point of view, the enlargement of the cervical chain, axillæ, or inguinal nodes, which are painless, hard, and often associated with considerable fibrosis, are common clinical findings. Biopsy is essential in the diagnosis of Hodgkin's disease.

Irradiation in Hodgkin's disease is of distinct palliative value and is in all probability the best form of therapy today. The prognosis is always grave. The majority of patients suffering from this disease succumb before the end of 3 years.

Of the 64 cases of Hodgkin's disease in patients under 30 years of age 5 were not treated, the 59 others were treated with 200 kilovolt X rays with the following results: Forty-eight patients died 21 in less than a year 14 in 1 to 2 years 7 in 2 to 3 years, 2 in 3 to 4 years 3 in 5 to 6 years, 1 in 6 to 7 years. Three were lost trace of 1 after having palliation for 2 years 1 after being clinically well for 1 year 5 months, 1 who was unimproved after treatment for 1 year. Eight are still alive 1 for 4 years but is now in the terminal stages of the disease 1 for 3 years 4 months, feeling well, 1 for 1 year 9 months who is having palliation 5 for less than a year since admission 2 are having palliation for 10 months and 11 months, respectively and 3 are not improving.

Thirty-one cases are available for 5 year statistics 4 or 12.8 per cent lived 5 years or more. Thirty nine cases are available for 3 year statistics of which 8 or 20 per cent have lived 3 years or more.

TABLE XVIII—LEUCEMIA, AGES

Age	8	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Lymphatic leucemia																					
Chloroma																					
Myelogenous leucemia															1					1	

LEUCEMIA

There were 20 cases of leucemia in patients under 30 years of age: 11 lymphatic leucemias, 1 chloroma, and 8 myelogenous leucemias (See also under lymphosarcomata 4 cases with aleucemic blood pictures.)

Table XVIII shows the ages of these patients: 11 males, 7 females.

The patients suffering from lymphatic leucemia complained of weakness, loss of weight, pain in various parts of the body and epistaxis. The majority of these patients suffered from their symptoms for only a few months. Upon examination there was found enlargement of the cervical axillary and inguinal nodes and enlargement of the spleen and liver. The original counts showed the hemoglobin ranged from 10 to 70 per cent, red blood count from 604,000 to 5,020,000, leucocyte count from 29,000 to 525,000, lymphocytes from 79 to 98 per cent. Under X-ray treatment a marked drop in leucocyte counts was noted. All of the patients in this group died within 6 weeks after admission. Six of the cases came to autopsy with the usual findings of a lymphatic leucemia.

X-ray treatments were given according to the total leucocyte count and the patient's general physical condition: doses of 25 to 40 per cent at 200 kilovolts. Patients were not treated if the total leucocyte fell below 30,000. Even in spite of this precaution in a few instances, the reduction in the total leucocyte count continued until they showed a decided leucopenia.

The chloroma occurred in a 5 year old female.

Her blood count on admission was: hemoglobin (Sahl) 70 per cent, red blood count 3,776,000, leucocyte count 27,000, myelocyte 1 per cent, polymorphonuclears 63 per cent, lymphocytes 30 per cent, monocytes 6 per cent. Following treatment with 200 kilovolt X-rays over the orbit, lumbar and sacral regions, the leucocyte count went down to 17,000 with a differential count of 64 per cent polymor-

phonuclears, 22 per cent small lymphocytes, 14 per cent large lymphocytes, and the patient was much improved for almost 3 months when the symptoms recurred and she succumbed to the disease 4 months after she was admitted to the hospital.

The patients suffering from myelogenous leucemia complained of the same symptoms except that most of them noticed enlargement of the abdomen and the duration of their symptoms was for a longer period of time: that is, from 6 months to 1 year and 10 months.

The original leucocyte counts ranged from 140,000 to 332,000. Following irradiation with 200 kilovolt X-rays there was a reduction in the total leucocyte counts and reduction in the size of the spleen. These patients were not irradiated if their general condition did not warrant it or if the total leucocyte count was below 30,000.

One of the patients died in 23 days from intestinal hemorrhage. The others lived from 5 months to 21 months. One patient is still alive 1 year after admission. At present the spleen is markedly enlarged and the leucocyte count is 187,000 although at one time it was as low as 12,600.

Two of these patients came to autopsy with the usual findings of myelogenous leucemia.

BIBLIOGRAPHY

- DEAVER, JOHN B. and McFARLAND, JOSEPH. *The Breast, its Anomalies, its Diseases and their Treatment*, p. 516. Philadelphia: P. Blakiston's Son & Co. 1917.
- EWING, JAMES. *Neoplastic Diseases*. Philadelphia: W. B. Saunders Company 1928.
- FOWLER, L. HAYDEN. Malignant epithelial neoplasms, carcinoma and epithelioma, occurring in persons under twenty-six years of age. *Surg. Gynec. & Obst.* 1928, 43: 73.
- HERZOG, CHARLES C., and THIBAUDEAU, A. A. Testicular testis. *Am. J. Cancer* 1934, 23: No. 3, Nov.
- HINDEMAN, F. Tumors of the testis. *Surg. Gynec. & Obst.*, 1935, 55: 490-491.
- LEE, BURTON J. Carcinoma of the breast in the young. *Internat. Surg. Digest*, 1931: 12: 399.

7. MATTHEWS FRANK S. The ten year survivors of radical mastectomy. *Ann Surg* 1911 68 615
8. PORTMANN G. and PHILLIPS R. Carcinoma of the Larynx in the young. Abstracted in *Am J Cancer* 1914 20: 189
9. SCHREINER, BERNARD F. Squamous cell carcinoma of the skin. *Am J Cancer* 1911 10: December
10. SCHREINER, BERNARD F., and MATTHEWS, WALLER I. Five year end results obtained by radiation treatment of cancer of the lip. *Am J Roentgenol* 1911 30: July
11. SCHREINER, BERNARD F. and MATTHEWS, WALLER I. Malignant neoplasms of the thyroid gland. *Ann Surg* 1914 January
12. SCHREINER, BERNARD F. and WEIR, WILLIAM H. Multiple primary cancer as observed at the State Institute for the Study of Malignant Disease. *Am J Cancer* 1911 20: Feb.
13. Idem. Malignant disease of the female generative organs in the first three decades of life. *Surg, Gynec & Obst* 1911 50: 616 621
14. SCHREINER, BERNARD F. and WEIR, RICHARD C. The cure of basal cell epithelioma. *J Am M Ass* 1910 91: 1475 1480
15. STOUT, ARTHUR L. Human Cancer. Philadelphia Lea & Febiger 1911
16. LUNNELL, A. V. and SCHREINER, B. F. Histological study of melanotic tumors and the effect of radiation treatment upon them. *Arch Clin Cancer Research* 1925 1: April
17. WILLIAMS, W. ROBERT. The Natural History of Cancer. p. 318. London Wm Heinemann 1908.

TABLE XVIII—LEUCEMIA, AGES

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BIBLIOGRAPHY

1. DEEVER, JOHN B. and McFARLAND, JOSEPH. The Breast: its Anomalies, its Diseases and their Treatment, p. 516. Philadelphia: P. Blakiston's Son & Co. 1917.
2. EWING, JAMES. Neoplastic Diseases. Philadelphia: W. B. Saunders Company 1928.
3. FOWLER, L. HAYES. Malignant epithelial neoplasms, carcinoma and epithelioma, occurring in persons under twenty-six years of age. Surg. Gynec. & Obst. 1926, 43: 73.
4. HENRIER, CHARLES C., and THORNTON, A. A. Testicular teratomas. Am. J. Cancer 1934, 27: No. 3.
5. HIRSHMAN, F. Tumors of the testis. Surg. Gynec. & Obst. 1933, 56: 450-461.
6. LEE, HENRIOT J. Carcinoma of the breast in the young. Internat. Surg. Digest, 1931, 12: 809.

- 7 MATTHEWS, FRANK S The ten year survivors of radical mastectomy Ann. Surg. 1933 98 635.
8. PORTMANN G and PHILLIP R. Carcinoma of the larynx in the young Abstracted in Am. J. Cancer 1934, 20 188.
9. SCHREINER, BERNARD F Squamous-cell carcinoma of the skin. Am J Cancer 1933 19 December
10. SCHREINER BERNARD F and ALATTICK, WALTER L. Five-year end-results obtained by radiation treatment of cancer of the lip Am. J. Roentgenol., 1933 30 July
- 11 SCHREINER, BERNARD F and MURPHY WALTER T Malignant neoplasms of the thyroid gland Ann Surg 1934, January
12. SCHREINER, BERNARD F., and WEHR, WILLIAM H Multiple primary cancer as observed at the State Institute for the Study of Malignant Disease. Am J Cancer, 1934, 20 Feb.
- 13 Idem. Malignant disease of the female generative organs in the first three decades of life. Surg Gynec. & Obst., 1934, 59 616-621
- 14 SCHREINER, BERNARD F., and WENDE, REINHARD C. The cure of basal cell epithelioma. J. Am. M. Ass., 1930, 94 1475-1480
- 15 STOUT, ARTHUR P Human Cancer Philadelphia Lea & Febiger 1932
- 16 THIBAUDEAU, A A and SCHREINER, B F Histological study of melanotic tumors and the effect of radiation treatment upon them Arch Clin. Cancer Research, 1935 1 April.
- 17 WILLIAMS, W ROGER The Natural History of Cancer p 318 London Wm Heinemann 1908.

A STUDY OF THE ACTION OF ERGOT ON THE HUMAN PUERPERAL UTERUS¹

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THE uncertainty concerning the therapeutic effects of various ergot preparations on the human uterus has led some clinicians to question their clinical value. A number of factors contribute to this uncertainty. The nature of the active principles of ergot has been the source of much controversy during recent years. It follows, therefore, that since the active elements have not been conclusively established, the standardization of activity is difficult. This difficulty is increased by the fact that uteri in different physiological states of the same species, and in the same physiological states in different species often give divergent results with the same agent. Again findings *in vitro* and *in vivo* do not always correspond. It is obvious that the most desirable form of confirmation of experimental findings lies in their clinical applicability. The following study was undertaken in order to investigate the relative clinical value of various ergot preparations.

A study of its history shows that ergot has some oxytocic effect on the human uterus. It was first described in Adam Lonicer's *Kreuterbuch* published in 1582 where it was mentioned as a proved means of inducing pains of the womb. In the 17th and 18th centuries midwives in most of the European countries used homemade preparations of ergot to stimulate labor pains. However it was not introduced into official medicine until the early part of the 19th century. In 1808 there appeared in *The Medical Repository of New York* an account of Pulvis Parturientis, a remedy for quickening childbirth. This was published in the form of a letter from Dr. John Stearns, then a practitioner in Saratoga County, New York. Four years later Dr. Oliver Prescott of Boston read a Dissertation on the Natural History and Medicinal Effects of Ergot. Subsequently ergot was used widely by physicians in this country to stimulate labor and to control postpartum

hemorrhage. Today of course the dangers of administering ergot before the termination of labor are well known and its use during this process has fallen into disrepute.

The original edition of the U. S. *Pharmacopoeia* in 1820 was the first official publication to admit ergot as a drug. Since this time a large amount of chemical and pharmacological work has been done to determine the nature of its active principles. It has been generally accepted that the activity of ergot lies in the alkaloidal fraction. Alkaloids were first shown to be present by Wenzell in 1864, but none was obtained in a state of purity until Tanret, in 1876, crystallized ergotinine, which proved to be practically inactive. Barger and Carr in 1906 isolated an alkaloid in the form of a crystalline salt, named ergotoxine. In the same year Kraft showed this alkaloid to be a hydrate of the ergotinine described by Tanret. Ergotoxine was investigated by Barger and Dale who believed it to be the active principle of ergot because of its ability to stimulate smooth muscle, and particularly uterine muscle, of the experimental animals used. Stoll in 1918 discovered a third alkaloid, ergotamine, which has a physiological activity indistinguishable from ergotoxine (Dale and Spiro 1922; Molr 1932). Until recently both ergotoxine and ergotamine were generally recognized as the active oxytocic principles of ergot. Still another ergot alkaloid, sensibamin, has recently been placed on the market as an oxytocic.

Much interest was aroused when Molr in 1932, working on the human puerperal uterus, found that aqueous ergot preparations, such as the fluid extract of the British *Pharmacopoeia*, showed an oxytocic effect far out of proportion to the amount of ergotoxine and ergotamine present. This interested us in particular since we have been using both aqueous and alcoholic preparations of ergot with apparently equally good clinical results.

¹Author is at present connected with the Department of Obstetrics and Gynecology, University of Chicago.

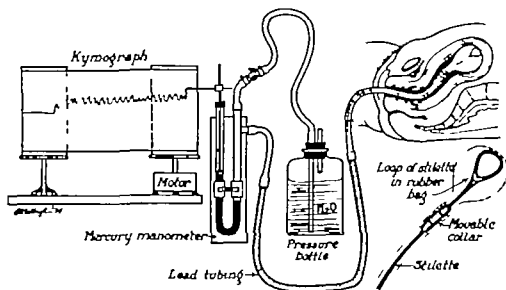


Fig. 1. Diagram of apparatus used showing position of hydrostatic bag in uterus. Stilette prevents bag from slipping down into cervix.

When assayed for the specific alkaloids by the Broom-Clark method, the aqueous preparation, ergotole, contained not over 0.15 milligrams per cubic centimeter while the alcoholic preparation, fluid extract of ergot U S P contained over 0.5 milligrams per cubic centimeter both in terms of ergotoxine as a standard.

A review of the literature shows that the accuracy of conclusions drawn from clinical observations on the efficacy of these ergot preparations is subject to doubt. Therefore it was decided to determine by a more direct method the relative oxytocic value of an aqueous extract (ergotole), U S P fluid extract of ergot and various other ergot preparations containing the isolated and presumably active alkaloids ergotoxine, ergotamine sensibamin

METHOD AND MATERIAL

The experiments were performed during the normal puerperium on patients who had had short uncomplicated labors and afebrile post partum courses. This group of cases was chosen for two reasons first because ergot preparations are used mainly during the puerperium, and second because there was less danger of infecting the patient. In order to make results more comparable each experiment was performed on the fifth or sixth day of the puerperium and at least 2 hours after the intake of food. A modification of the

method described by Bourne and Burn in 1927 and further elaborated by Moir in 1932, was used. A sterilized watch shaped rubber bag was introduced through the cervix into the uterus by means of a stilette. The bag was connected by lead tubing to a mercury manometer which was fitted with a float and marker for recording contractions on a revolving smoked drum. The bag was inflated with water to a pressure equivalent to 20 millimeters of mercury (Fig. 1).

Sixty two satisfactory experiments have been executed and the following preparations have been tested in the stated number of cases

- 1 Fluid extract of ergot U S P—10 cases
- 2 Ergotole—8 cases
- 3 Ergotamine tartrate—10 cases
- 4 Ergotoxine ethane sulphonate—8 cases
- 5 Ernutin (a preparation which contains histamine tyramine and ergotoxine) 3 cases
- 6 Histamine—4 cases
- 7 Sensibamin—6 cases.
- 8 An ergot preparation¹ from which all the alkaloids were removed—4 cases.
- 9 A preparation¹ which contained all the alkaloids of ergot—4 cases
- 10 A preparation¹ containing the alkaloids of ergot except ergotoxine—2 cases

¹Prepared by Professor Marvin R. Thompson, Department of Pharmacology University of Maryland. The pharmacology and chemistry of these preparations is being reported elsewhere by Dr. Thompson.

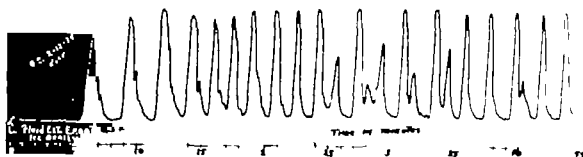


Fig. 2. Fluid extract of ergot USP 1 cubic centimeter (equivalent to 0.5 milligram specific alkaloids by assay). Oral administration. Onset of contractions in 5½ minutes. Rise above base line indicated slight tonic. Regular and intermittent contractions lasted over 2 hours.

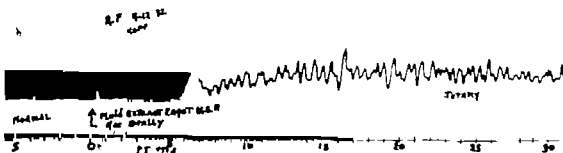


Fig. 3. Fluid extract of ergot USP 4 cubic centimeters (equivalent to 2.0 milligrams specific alkaloid by assay). Oral administration. Contractions began in 6 minutes. Rise above base line indicated sustained tonic contractions. This is typical fluid extract curve. Duration of tetany 1 hour and 50 minutes.

11. A synthetic preparation resembling fluid extract of ergot—3 cases.

In most cases a different patient was used for each test because the long duration of the action of some of these preparations prevented the recording of two experiments on one individual. No 2 patients produced exactly the same type of tracing. One uterus was entirely inactive, another very active. In general, three types of physiological reactions occurred: (1) Very active uteri showed contractions every 2 to 3 minutes. (2) Moderately active uteri showed strong contractions every 15 to 20 minutes. (3) Inactive uteri showed occasional weak contractions or none at all.

The effects of these ergot preparations are illustrated on the inactive uterus only since the results are more comparable. When pos-

sible each ergot preparation was tested by oral, subcutaneous, intramuscular and intravenous administration.

ORAL ADMINISTRATION OF ERGOT PREPARATIONS

From Figures 2 and 3 it may be seen that fluid extract of ergot standardized to contain 0.5 milligrams per cubic centimeter of specific alkaloids produced the expected degree of oxytocic effect. However, ergotole, (Figs. 4 and 5) an aqueous preparation containing not over 0.15 milligrams per cubic centimeter ($\frac{3}{4}$ the value in terms of specific alkaloidal content) produced almost exactly the same effect from the standpoint of the onset, duration and degree of tonic contractions of the uterus. It is surprising as Moir (1932) pointed out that

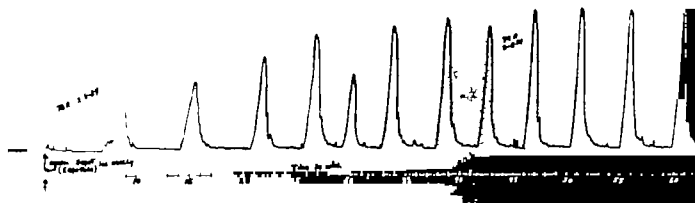


Fig. 4. Aqueous extract (ergotole) 1 cubic centimeter (equivalent to 0.15 milligram specific alkaloids by assay) Oral administration. Contractions began in 9 minutes. Absence of rise above base line indicated lack of tonus increase (compare with Fig. 1). Contractions continued for over 3 hours.

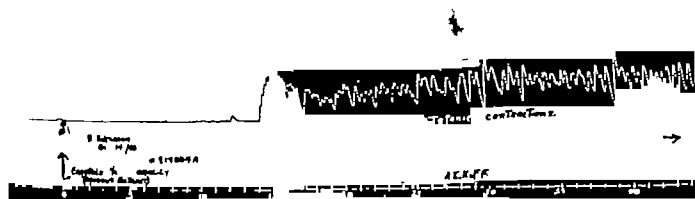


Fig. 5. Ergotole 4 cubic centimeters (equivalent to 0.64 milligram specific alkaloids) Oral administration. Contractions began in 14 minutes. Rise above base line indicated sustained tonic contractions. Duration of tetany 1 hour and 6 minutes.

aqueous preparations of ergot which contain very small amounts of the presumably active principles should have an oxytocic effect that is so great. Our experiments have demonstrated that this effect is far out of proportion to the amount of the so called specific alkaloids present in solution (Fig. 6).

The observations recorded in Figures 6, 7, 8 and 9 indicate that ergotamine, ergotoxine, and sensibamin given by mouth, even in large doses, do not exert rapid or great enough oxytocic effect to be of clinical value in obstetrics. This work substantiates the statement of Mour that "Oral administration of ergotoxine and ergotamine even in doses of 2 milligrams did not yield consistent results." We wish to

draw particular attention to Figure 8 which compares the effect of 2 milligrams of the specific alkaloid ergotamine tartrate with that of 4 cubic centimeters of the aqueous preparation (4 cubic centimeters contains 0.64 milligrams of specific alkaloid). Here, the rapid and powerful effect of the aqueous preparation when compared with the absence of any effect from administration of the specific alkaloid is striking evidence that ergotamine is not responsible for the major oxytocic action of ergot.

On the basis of pharmacological investigation it has been generally accepted that ergotoxine or ergotamine was essential for the efficacy of ergot preparations. Preparations

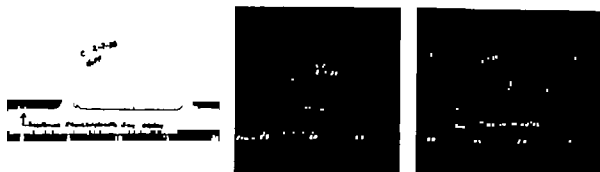


Fig 6 Ergotamine ethane sulphonate, 3 milligrams orally. Onset of contractions occurred in 54 minutes. No sustained rise above the base line indicated lack of tonic increase. Contractions are intermittent and irregular. (Three milligrams of ergotamine is equivalent by assay to 30 cubic centimeters aqueous preparation.) Tracing was continuous but only sections of it are shown as indicated by the record.

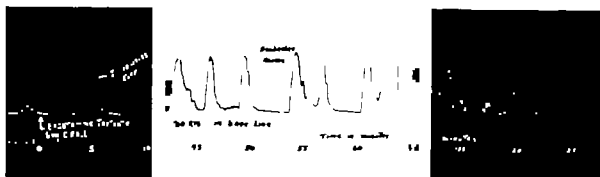


Fig 7 Ergotamine tartrate, 6 milligrams orally. Contractions began in 43 minutes. N rise above the base line indicated lack of tonic increase. Duration of contractions was 2 hours. (Six milligrams ergotamine is equivalent to 15 cubic centimeters U S P fluid extract of ergot.)

containing negligible quantities of these alkaloids were therefore considered inert by many authorities. Contrary to this opinion administration of aqueous preparations containing insignificant amounts of the specific alkaloids produces a degree of uterine muscle spasm considerably in excess of that produced by the alkaloids ergotamine, ergotamine and sensibamin. This suggests that ergot may contain a substance hitherto unidentified which is responsible for the major oxytocic effect.

In general it may be said that when given orally in proper dosage (4 cubic centimeters or over) both the aqueous preparation ergotole and U S P fluid extract of ergot produce a rapid and powerful oxytocic effect. On the other hand, the action of ergotamine, ergotamine, and sensibamin by oral administration is so slow and inconsistent that the clinical use of these drugs when given by mouth seems of doubtful value.

INTRAMUSCULAR ADMINISTRATION OF ERGOT PREPARATIONS

It has been possible to obtain consistently good results by intramuscular administration of these alkaloids (ergotamine ethane sulphonate ergotamine tartrate [gynergen] sensibamin) only in doses of 2 milligrams or over (Figs. 10, 11 and 12). In some of these cases, shortly after administration, the patients developed headaches, blurring of vision and nausea, particularly after the administration of ergotamine. The results shown here and the numerous clinical reports on ergotamine and ergotamine leave no doubt that these alkaloids are effective parenterally. Nevertheless, these alkaloids were practically inactive by mouth, and administration by the intramuscular route was often associated with toxic symptoms. These facts render these drugs less valuable and less dependable. The fact that no symptoms occurred when large

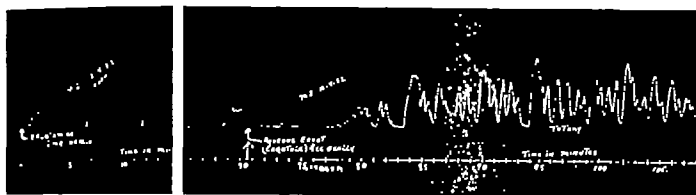


Fig. 8 Ergotamine tartrate 2 milligrams orally. No contractions during 1 hour. Four cubic centimeters aqueous ergot given to same patient for comparison of effect. Contractions began in 12 minutes. Marked rise in base line indicating tonic contractions. (Two milligrams ergotamine is equivalent by assay to 13 cubic centimeters aqueous ergot [ergotole].)

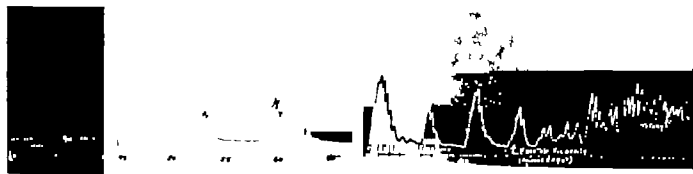


Fig. 9 Sensibamin, 4 cubic centimeters (2 milligrams) orally. Contractions began in 30 minutes. No rise in base line. Four cubic centimeters ergotole given as control. Onset of contractions in 6 minutes followed by strong tetany. Only sections of tracings are shown.

doses of ergotoxine and ergotamine were given by mouth would seem to indicate that these alkaloids are probably very slowly absorbed from the intestine. Burn in 1929 estimated that something like 30 per cent is absorbed from the cat's intestine. Nevertheless, taking this into consideration one should obtain better results than those heretofore shown from the large doses administered by mouth.

It has been claimed by some authors (Jaeger 1913) that the oxytocic effect of ergot is due to histamine. Thompson found in a series of 10 ergot samples a percentage of histamine ranging from 0.012 to 0.150. In our experience histamine exerted no oxytocic effect by mouth and only a transitory effect when given intramuscularly as was emphasized by Thompson in 1930 (Fig. 13).

ORAL ADMINISTRATION OF ERGOT FRACTIONS

It is clear from this study that when given orally and subcutaneously aqueous ergot preparations which contain not more than

traces of ergotoxine and ergotamine show an oxytocic effect far out of proportion to the activity exhibited by the specific alkaloids present in the solution. These alkaloids—ergotamine, ergotoxine, sensibilin—are practically inactive by mouth. Moreover they do not stimulate the uterus to the expected pharmacological activity when given by either the intramuscular or intravenous route. This suggests that the action of ergot cannot be entirely due to ergotoxine, ergotamine or sensibilin. In fact it implies the presence of some more active substance, probably water soluble, since aqueous ergot preparations were very active. With this in mind an attempt was made to divide ergot into fractions in order to determine as much as possible the identity of the unknown principle.

Through the courtesy of Dr. Marvin Thompson three fractions¹ were obtained for testing.

The chemical and pharmacological details regarding these fractions were presented before the scientific section, annual meeting of the American Pharmaceutical Association at Washington, D. C., and are in press.



Fig. 10. Ergotamine ethane sulphonate, 2 milligrams intramuscularly. Contractions began in 13 minutes. Rise above the base line indicated increase in tonus. Tetany for 34 minutes followed by strong intermittent contractions.

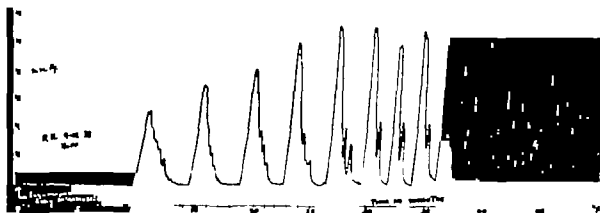


Fig. 11. Ergotamine tartrate (gynergen) 2 milligrams intramuscularly. Contractions began in 10 minutes. Contractions at first strong and intermittent followed by a period of tetany lasting 65 minutes.

1 Alkaloid-free fraction containing essentially all extractives of ergot except the total alkaloids (Fig. 14)

2 Total alkaloidal fraction remaining after removal of fraction 1 (Fig. 14)

3 A fraction resulting after the chemical removal of essentially all of the ergotoxine, ergotamine and ergotamine from fraction 2 (Fig. 15)

Each fraction was made up so that the dosage of 1 cubic centimeter was equivalent to its amount in 1 gram of crude ergot.

From Figure 14 it may be seen that the fraction of ergot that did not contain alkaloids was absolutely inactive. Since the alkaloidal fraction did produce as rapid and powerful an effect as that obtained by oral administration

of aqueous and alcoholic whole extracts of ergot one may say unequivocally that the activity of ergot lies in, or is associated with this alkaloidal fraction (Fig. 14). It is probably true that during the process of extraction some of the activity is lost. It is evident, as shown in Figure 15 that even though the ergotoxine was removed the remaining alkaloidal fraction had a high degree of activity. As far as we can make out this alkaloidal fraction is responsible for most of the oxytocic action of ergot.

EVALUATION

It is the custom of most obstetricians to prescribe ergot preparations following the third stage of labor in order to produce tonic contractions of the uterus. The objects of

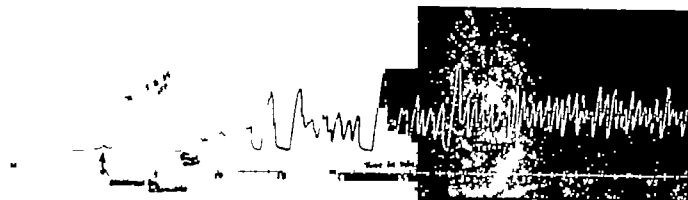


Fig 12. Sensibamin 2 cubic centimeters intramuscularly. Contractions began in 6½ minutes. Strong tetany for 1 hour and 46 minutes.

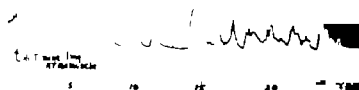


Fig 13. Histamine 1 milligram intramuscularly. Contractions began in 1½ minutes. Rise in base line indicated tetany which lasted 6 minutes followed by weak, irregular contractions. Comparison of the effect of 4 cubic centimeters ergotone on the same patient. Tracing is continuous but only parts are shown.

this treatment are mainly to control immediate and delayed postpartum bleeding to favor involution of the uterus, to diminish the likelihood of postpartum infection by expelling retained lochia. Moreover, in some clinics ergot preparations are given in order to complete abortions in cases in which secundines are retained. Practically all authorities deprecate strongly the use of ergot during any stage of labor, mainly because of the danger of rupture of the uterus and asphyxia to the child due to tetanic contractions of the uterine muscle.

It should be stated here that we consider an oxytocic drug clinically valuable when its action is rapid and consistent, and the contractions tetanic and of long duration. For the control of hemorrhage, rapid action and tetanic contractions are obviously necessary. Any drug that produces only intermittent contractions will allow bleeding to take place during the intervals and is therefore of little value. It is generally stated that drugs which

exert a prolonged and tetanic effect are more desirable in furthering involution. This opinion is probably based on the observation that postpartum uteri involute more rapidly when strongly contracted.

The task of evaluating clinical reports on the merits of various ergot preparations is difficult mainly because a large number of the constituents extractable from the crude drug exert a greater or lesser degree of oxytocic effect. Numerous attempts have been made to isolate the specific or active principles, and on the basis of the pharmacological results on laboratory animals most of these extractives have been given a fair clinical trial. These extractable constituents of ergot were classified by Thompson (1930) as follows:

1. Specific alkaloids such as ergotoxine, ergotinine, ergotamine, and ergotaminine.
2. Non specific amines such as histamine, tyramine, acetyl choline.
3. Inert extractions. These consist of one or more pigments 10 to 35 per cent of fixed



FIG. 14. Fraction 1 (alkaloid free) 10 cubic centimeters orally. There was no stimulation of uterine muscle indicating lack of oxytocic activity. Compare effect of 4 cubic centimeters alkaloidal fraction No. 2. Contractions began in 8 minutes. Strong intermittent contractions with marked rise in the base line indicated uterine muscle spasm.

oil, small amounts of inorganic salts and appreciable quantities of proteinogenous substances.

On the basis of pharmacological studies of the specific alkaloids only ergotoxine and ergotamine stimulate uterine contractions. Of the non-specific amines, histamine and tyramine exert a weak oxytocic effect.

Very few reports on the clinical action of ergotoxine are available. Kehrer (1911) found that injections of 1 to 2 milligrams were ineffective. Sharp (1911) found its action when injected more prompt but weaker than whole ergot preparations. Moir (1932) discovered ergotoxine to be very active when given parenterally but practically inactive by mouth. Using muscle strips from the human uterus, Robson (1933) found ergotoxine to be very active *in vitro*.

Jaeger (1913), Bourne and Burn (1927) and others found that hypodermic administrations of histamine stimulated the uterus during labor but noted unpleasant side effects such as headaches, flushing and nausea. Kehrer (1911) on the other hand, was unable to confirm the findings of uterine stimulation. Using tyramine, Heimann (1912) concluded that this drug produced a desirable oxytocic effect (without the toxic effects of histamine).

Since the isolation of ergotamine in 1918 numerous favorable clinical reports have appeared with both intramuscular and oral administration of this drug. Hellman (1927) recommends ergotamine for postpartum hem-

orrhage, incomplete abortion, menorrhagia, and metrorrhagia. According to this author hypodermic and oral administration are of equal value. Turolt (1923) makes the same recommendations and uses ergotamine successfully in the completion of incomplete abortion. Bourne and Burn (1927) state that ergotamine produced a powerful contraction of the uterus for 16 hours during the first stage of labor when 1 milligram was injected intramuscularly. Suchs (1932) found that gynergen (ergotamine tartrate) when given by mouth increased the rate of involution of the puerperal uterus. Moir (1932) discovered that ergotamine when given by mouth, exerted a very weak effect, and was quite active when injected intravenously or intramuscularly. On the other hand, Adair and Davis (1934) also recording contractions by means of a balloon in the uterine cavity connected to a recording manometer were unable to show any effect on the contractions or muscle tone of the uterus by injection of 1 cubic centimeter of gynergen intramuscularly.

One can readily understand that from these divergent results of clinical investigation it is difficult to draw very definite conclusions. Nevertheless on the basis of the pharmacological and clinical data, both ergotamine and ergotoxine have become generally recognized as the active or specific principles mainly responsible for the major oxytocic effect of ergot. As a result, an attempt has been made to standardize ergot with respect

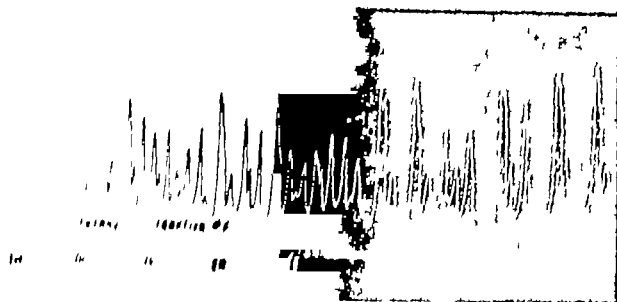


FIG. 14, continued

both specific all-alcohol content. The U.S.P. standard of yep in order to be official is analyzed so that each cubic centimeter contains the pharmacological equivalent of at least 100 milligrams of these all-alcohol. These U.S.P. fluid extract of yep is very strong, we believe this standard to be of little value, particularly since oral administration of specific extracts of yep produces more rapid and more powerful uterine contractions than the specific all-alcohol given in the same amount. Since it is well known that the extract of yep with water removes the more specific and appreciable amounts of all-alcohol, but only insignificant amounts of the supposed all-important all-alcohol (specific and euphoric), the powerful oxytocic effect of aqueous extracts supports the theory of an active constituent of yep as a substance. Moreover, the rapid, powerful and persistent stimulation of the human pericardiac by aqueous extracts and is observed that either euphoric or specific may be possible for more than a slight effect.

The effect of the infusion of yep into the all-alcohol and all-alcohol fractions shows clearly that the former is inert while the latter contains the active principle. Whether or not this substance is an all-alcohol, or more chemical, is not clearly associated with the all-alcohol fraction, is at present not clear. It is only by comparing the tracings of fluid ex-

tract of yep and the all-alcohol fraction that during the process of extraction of the latter a large amount of oxytocic activity is lost. The assay shows that this is so not in terms of euphoric or euphoric. Moreover, a synthetic preparation of yep containing the non-all-alcohol fraction to which were added euphoric ethane sulphonic acid, histamine, histate and histamine in approximately the proportions found in U.S.P. fluid extract of yep was practically inactive when given by mouth. This observation eliminates the possibility that oxytocin between euphoric, euphoric and histamine on the one hand and substances in the non-specific portion on the other hand, is responsible for the oxytocic effect of fluid extract of yep. Moreover, it supports the view that the major oxytocic activity of yep is due to a chemical substance as yet unidentified. Until this new principle is isolated and an accurate method of standardization found, it is probably wiser for clinicians to use extracts of whole yep.

PREPARATION AND CONCENTRATION

1. Oral administration of fluid extract of yep (U.S.P.) and aqueous euphoric produces remarkable activity in stimulating contractions of the human pericardiac uterus.

The onset of contractions varies from 5 to 15 minutes. The contractions are tonic, and the tonus is of long duration. The optimum dosage is between 3 and 8 cubic centimeters.

TABLE I—RESULTS

Table I is a tabulation of 39 experiments all done on the sixth day of the puerperium.
The uteri were inactive and practically in the same physiological state.

Drug	Dose	Mode of administration	Time of onset	Duration of tetanus	Remarks
Fluid extract ergot U S P	cm (1 mgm.)	Oral	5 1/2 min.	None	Intermittent strong contractions
Fluid extract ergot U S P	0.5 cm. (1/2 mgm.)	Oral	8 min.	Slight, 1 min.	Intermittent strong contractions
Fluid extract ergot U S P	3 cm (3 mgm.)	Oral	9 min.	hr 3 min.	Tetany followed by strong contractions
Fluid extract ergot U S P	4 cm (4 mgm.)	Oral	6 min.	hr 20 min.	Tetany followed by strong contractions
Fluid extract ergot U S P	4 c.cm (4 mgm.)	Oral	14 min.	hr 21 min.	Tetany followed by strong contractions
Fluid extract ergot U S P	8 c.cm (8 mgm.)	Oral	7 min.	hrs plus	Tetany followed by strong contractions
Aqueous ergot (ergotole)	0.5 cm (0.5 mgm.)	Oral	7 min.	None	Strong contractions every 1 to 3 minutes
Aqueous ergot (ergotole)	cm (1 mgm.)	Oral	min.	Transient	Strong contractions every 1 to 3 minutes
Aqueous ergot (ergotole)	4 c.cm (4 mgm.)	Oral	14 min.	hr 6 min.	Tetany followed by strong contractions
Aqueous ergot (ergotole)	4 c.cm (4 mgm.)	Oral	9 min.	hr plus	Tetany
Aqueous ergot (ergotole)	4 c.cm (4 mgm.)	Oral	7 min.	hr 40 min.	Tetany followed by strong contractions
Aqueous ergot (ergotole)	cm (1 mgm.)	Oral	6 min.	20 min plus	Tetany
Aqueous ergot (ergotole)	3 c.cm (3 mgm.)	Oral	9 min.	hr 10 min.	Tetany followed by strong contractions
Aqueous ergot (ergotole)	6 c.cm (6 mgm.)	Oral	3 min.	Over hrs	Strong tetany
Aqueous ergot (ergotole)	8 cm (8 mgm.)	Oral	7 min.	hr 30 min.	Strong tetany
Aqueous ergot (ergotole)	10 m (1 mgm.)	Subcutaneous	min.	30 min.	Gradual onset of contractions
Aqueous ergot (ergotole)	10 m (1 mgm.)	Intramuscular	min.	40 min.	Gradual onset of contractions
Ergotamine ethane sulphonate	mgm.	Oral	36 min.	None	Occasional weak contractions
Ergotamine ethane sulphonate	mgm.	Oral	28 min.	Transient	Weak contractions every 3 min.
Ergotamine ethane sulphonate	3 mgm.	Oral	24 min.	Transient	Strong intermittent contractions 1 to 3 min.
Ergotamine ethane sulphonate	mgm.	Intramuscular	23 min.	Transient	Weak intermittent contractions
Ergotamine ethane sulphonate	mgm.	Intramuscular	3 min.	hr.	Strong contractions followed by tetany
Ergotamine ethane sulphonate	3 mgm.	Intramuscular	14 min.	30 min.	Gradual onset of contractions
Ergotamine ethane sulphonate	30 m.	Intravenous	min.	30 min.	Gradual onset of contractions
Ergotamine tartrate (gynergen)	mgm.	Oral	23 min.	None	Weak contractions every 3 to 5 min.
Ergotamine tartrate (gynergen)	mgm.	Oral	41 min.	None	No contractions in hr. 3 min.
Ergotamine tartrate (gynergen)	6 mgm.	Oral	41 min.	None	Strong irregular contractions disappearing in hr.
Ergotamine tartrate (gynergen)	mgm.	Intramuscular	min.	3 min.	Gradual onset
Ergotamine tartrate (gynergen)	mgm.	Intramuscular	min.	45 min.	Gradual onset. Strong contractions followed by tetany
Ergotamine tartrate (gynergen)	20 m (6 mgm.)	Intravenous	8 min.	30 min.	Gradual onset
Amboleson (ergone)	4 c.cm	Oral	30 min.	None	Irregular weak contractions
Amboleson (ergone)	cm	Intramuscular	15 min.	Transient	Good contractions
Amboleson (ergone)	cm	Intramuscular	6 min.	hr 40 min.	Weak contractions
Ergonov	cm (1 mgm.)	Oral	1 min.	None	Weak contractions
Flutamine	mgm.	Intramuscular	10 min.	min.	Tetany followed by weak contractions
Flutamine	mgm.	Oral	No effect	No effect	No effect
Alkaloidal free ergot fraction	cm (0 mgm.)	Oral	No effect	No effect	No effect in hrs.
Alkaloidal free ergot fraction	3 c.cm (3 mgm.)	Oral	No effect	No effect	No effect in hrs.
Alkaloidal fraction	cm (1 mgm.)	Oral	8 min.	20 min.	Gradual onset of tonic contractions
Alkaloidal fraction 3 Ergotamine removed	3 cm (3 mgm.)	Oral	9 min.	37 min.	Tetany alternating with contractions
Alkaloidal fraction 3 Ergotamine removed	6 c.cm (1000)	Oral	8 min.	23 min.	Tetany alternating with contractions

All preparations except those prepared by Dr. M. Thompson were obtained from the Johns Hopkins Hospital pharmacy. Ergotole and fluid extract of ergot were assayed by the Broom-Clark method. Ergotole contains not over 0.5 mgm. per c cm. of ergotamine. Fluid extract Ergot U S P contains not less than 0.5 mgm. per c cm. of ergotamine. Equivalents given in mgm. in this table are on basis of assay by the Broom-Clark method.

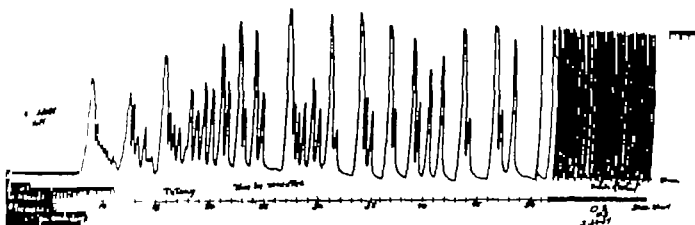


Fig. 15 Fraction 3 (total alkaloids with most of the ergotoxine removed), 4 cubic centimeters orally. Contractions begin in 15 minutes. Strong contractions alternating with periods of tetany lasted over 3 hours, 30 minutes.

2 Oral administration of ergotoxine, ergotamine, and sensibamin give slow and variable results. The onset of their action varies between 25 and 55 minutes. The contractions are weak and irregular and tonus is absent. These drugs given by mouth are of no clinical value in the puerperium.

3 Aqueous ergot preparations induce an activity far out of proportion to the amount of the hitherto identified specific alkaloids present in the solution. This fact suggests that ergot also contains an unidentified active principle.

4. Ergotoxine, ergotamine, and sensibamin by intramuscular and intravenous routes are indistinguishable from each other in their oxytocic effect on the postpartum uterus. Dosage of 2 milligrams of these alkaloids by the intramuscular route in the majority of cases produces a good clinical effect but unpleasant side effects with this dosage are occasionally experienced. In doses of less than 2 milligrams the results are often variable.

5 Fluid extract of ergot U.S.P. and aqueous extract (ergotole) produce a more rapid, stronger, and lasting effect by mouth than ergotamine, ergotoxine, and sensibamin when given by the intramuscular route.

6 Histamine when given by mouth, is inactive, and by the intramuscular route has a rapid but slight, oxytocic effect.

7 Fractions of ergot containing no alkaloids as determined by the Thompson method of extraction when given by mouth in large doses, exert no oxytocic effect.

8 Fractions of ergot containing nothing but the total alkaloids exert an oxytocic effect similar to the U.S.P. fluid extract of ergot and to aqueous extract. This indicates that the active principle is either an alkaloid or some chemical substance closely associated with the alkaloidal fraction.

9 Alkaloidal fractions ergotoxine having been removed exert an oxytocic effect identical with that produced when ergotoxine is present. This indicates that ergotoxine is not responsible for the major effects.

BIBLIOGRAPHY

1. ADAMS, F. L. and DAVIS, M. E. A study of human uterine motility. *Am. J. Obst. & Gynec.*, 1934, 27, 383.
2. BARBER, G. S. Ergot and Ergotism. 1931, p. 7.
3. BARBER, G. S. and CARR, F. H. Note on ergot alkaloids. *Chem. News*, 1906, 94, 89.
4. BARBER, G. S., and DALE, H. H. Ergotoxine and some other constituents of ergot. *Bio-Chem. J.*, 1907, 1, 240-250.
5. BOUVERIE, A., and BURR, J. H. The dosage and action of pituitary extract and of the ergot alkaloids on the uterus in labour. *J. Obst. & Gynec. Brit. Emp.*, 1927, 34, 249-268.
6. BROOK, W. A., and CLARK, A. J. The standardization of ergot preparations. *J. Pharmacol. & Exper. Therap.*, 1923, 22, 59-74.
7. BURR, J. H. The oral administration of ergot. *Quart. J. Pharm. & Pharmacol.* 1929, 2, 515-524.
8. DALE, H. H. and SPIRO, K. Die wirksamen Alkaloide des Mutterkorns. *Arch. f. exper. Path. u. Pharmacol.* 1922, 95, 337-350.
9. HELLMANN, E. Chemische physiologische und klinische Studien ueber Systogen ein synthetisches Skelett-Ersatz praeparat. *Muenchen med. Wchnschr.* 1912, 59, 1370.
10. HELLMANN, A. M. Obstetrical and gynecological uses of ergotamine, the principal active alkaloid of ergot. *M. J. & Rec.* 1927 Jan.

- 11 JAEGER F Versuche zur Verwendung des B Imids
polyethylamine in der Geburtshilfe. *Zentralbl f
Gynaek* 1913 37 265-269
- 12 KREMER, E. Klinische experimentelle Untersuchungen
ueber die Wehentätigkeit des menschlichen
Uterus. *Verhandl. d. deutsch. Gesellsch. f. Gynaek.*
1911 14 680
- 13 KRAUT F Ueber das Mutterkorn *Arch. d. Pharm.*
1906, 244 336-350
- 14 MOORE, C. The action of ergot preparations on the
puerperal uterus. *Brit. M. J.* 1932, June 18
- 15 Idem. Clinical comparison of ergotamine and ergo-
tamine. *Brit. M. J.* 1932, June 4
- 16 PARKER, DAVIS and COMPANY. Ergone: a standardized
solution of sennabimbin: a new ergot alkaloid. 1934
- 17 PRINCE, O. A dissertation on the natural history
and medicinal effects of the secale cornutum, or
ergot. Quoted from G. S. Barger. *Ergot and ergo-
tism*, p. 15-16
- 18 ROSSOW J M. The reactivity and activity of the
rabbit's uterus during pregnancy parturition, and
the puerperium. *J. Physiol.* 1933, 78 300
19. SNIER J G. Ergot, a clinical study. *Proc. Roy.
Soc. Med.* 1911 4 114 150.
- 20 STOLL, A. Zur Kenntnis der Mutterkorn Alkaloide.
Verhandl. schweiz. naturf. Gesellsch. 1920, p. 190
- 21 STOKES, J. Ergot prophylaxis and ergot therapy in the
puerperium. *M. J. & Rec.*, 1932, Dec.
- 22 TAVIET, CHARLES. Sur la presence d'un nouvel alka-
loide, l'ergotinine dans le secale ergote. *J. de pharm.
et chim.* 18-6, 23 17-10
- 23 THOMPSON, M. R. The pharmacology of ergot. Part
IX. *J. Am. Pharm.* 1930, 19 705
- 24 Ibid. pp. 11-23
- 25 THOMAS, H. J. Stomach and Puhle parturient. *Am. J.
Obst. & Gynec.*, Sept. 1931 22 418
- 26 TROUPEL M. Ueber Gynexen. *Med. Klin.* 19 3, 19
p. 1159-1160

THE PRESENT STATUS OF THE STERILITY OF SURGICAL CATGUT SUTURES

WITH PARTICULAR REFERENCE TO AMERICAN MADE CATGUT

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AS a result of his finding (6) virulent spore forming anaerobic bacteria of the gas gangrene group in a batch of catgut sutures used in the operative wounds of 5 patients in a New York City hospital, and in whom fatal gas gangrene occurred—coupled with his recovery of the same organism from one of the fatal cases—a comprehensive study of the sterility of catgut was proposed by Dr Frank L. Meloney. His aim was that it shall not be possible for anyone to buy on the market catgut that is not absolutely sterile (4).

At the Clinical Congress of the American College of Surgeons in 1929 Meloney (4) reported the results of his preliminary study. He stated

The Hospital Standardization Committee of the American College of Surgeons promised that if the results of this study were entirely satisfactory they would recommend the products of only those firms which were willing to subject their goods to this test, not occasionally but with specimens from every single sterilized batch of material. It was felt that all of the reputable firms would be willing to follow the lead in the matter and adopt the standard test and any firms which did not fall into line would find no market for their goods. If hospitals and doctors

the country, over then followed the advice of the committee they could buy catgut with perfect confidence and perfect security and the risk of fatal accidents such as I have described would be reduced to a minimum.

Later Meloney and Chatfield (5) submitted an effective test for the sterility of catgut and reported that the products of ten firms had been found sterile while the sutures of seven firms proved to be non-sterile when subjected to this test.

In view of this excellent and comprehensive bacteriological study it is most unfortunate that the Meloney and Chatfield technique was not adopted as a standard method to be enforced by some controlling authority. As so aptly stated by Meloney (4)

I believe that you will all agree with me in this, that there should never be any competition of catgut firms in the matter of sterility. Their products may vie with one another with respect to other physical characteristics—tensile strength, absorbability and what not, but they should all have the common factor of sterility. There is no relative about sterility. It is an absolute term which means the absence of living elements.

For the purpose of determining the practical value of the Meloney and Chatfield test for

TABLE I—TOTAL QUANTITY TESTED OF THE TWELVE AMERICAN BRANDS OF CATGUT SUTURES

Year	Number of lots	Number of sutures
1929	87	916
1930	101	1,064
1931	142	1,482
1932	136	1,330
1933	139	1,392
Totals	605	6,184

sterility of catgut, especially since it was proposed to establish the test as a standard. It seemed highly desirable to apply this technique to a large number of lots of sutures of all of the American brands over a considerable period of time. I decided to undertake such an investigation and, beginning early in 1930 and continuing each year thereafter I purchased periodically in the open market several lots of sutures of each of the twelve American brands of catgut.

During the course of this investigation I made an intensive study of the possibility of effectively sterilizing catgut by means of chemical treatment. My research on that subject (2) showed the necessity of making chemical analyses of some of the sutures before subjecting the lot to bacteriological examination, and it also emphasized the importance of using as a preliminary step in the technique suitable neutralizing fluids to dissolve and remove any chemical with which the sutures might be impregnated. Further I devised and recommended three additional controls and further safeguards for use with the Meleney and Chatfield test.

The present investigation involved a total of 605 lots comprising 6,184 catgut sutures tested during a period of five consecutive years including 1930, 1931, 1932, 1933, and 1934 (Table I). The sutures were examined bacteriologically by the Meleney and Chatfield method, or, by their method in conjunction with the use of the special neutralizing solutions which I have previously reported (2).

Results in 1930 Tests were applied to 87 lots comprising 916 catgut sutures. Seven brands were uniformly sterile while the five brands of Manufacturers A, E, F, G and I were found to be non-sterile (see Table II).

TABLE II—PERCENTAGE OF NON STERILE LOTS OF CATGUT SUTURES OF THE TWELVE AMERICAN BRANDS

Manufacturer	1930 per cent	1931 per cent	1932 per cent	1933 per cent	1934 per cent
A	100	50	78	85	91
B	0	0	0	0	0
C	0	0	0	0	0
D	0	0	0	0	0
E	20	57	83	0	0
F	50	100	88	57	33
G	100	42	12	0	25
H	0	0	0	0	0
I	5	0	18	16	12
J	0	33	0	33	0
K	0	0	0	0	0
L	0	0	0	0	0

Results in 1931 This year, 101 lots representing 1,064 catgut sutures were tested. Again seven brands were sterile, while the five brands of Manufacturers A, E, F, G and I were non sterile. Four of these non-sterile brands (products of Manufacturers A, E, F and G) were also non sterile in 1930 (see Table II).

Results in 1932 In this year, 142 lots consisting of 1,482 catgut sutures were subjected to tests for sterility. Again, seven brands were uniformly sterile while the five brands made by Manufacturers A, E, F, G and I were non sterile. These are the same five brands which proved to be non-sterile in 1930, and four of them (products of Manufacturers A, E, F and G) were also found non-sterile in 1931 (see Table II).

Results in 1933 Tests were applied this year to 136 lots comprising 1,330 sutures. Eight brands were sterile while the four brands of Manufacturers A, E, F, G and I were found to be non sterile. Two of these non sterile brands marketed by Manufacturers A and F, were also non-sterile in 1931 and 1932. One brand the product of Manufacturer I, was found non-sterile in 1930 and 1932. The other non-sterile brand marketed by Manufacturer J, was found non-sterile in 1931 but was found sterile in 1932 (see Table II).

Results in 1934 Tests were applied this year to 139 lots comprising 1,392 catgut sutures. Seven brands were uniformly sterile while the five brands made by Manufacturers A, E, F, G and I were non sterile. Three of these five brands which proved

also in 1930 and 1932. Two of these non sterile brands, made by Manufacturers A and F were found non sterile also in 1931 and 1933. Two non sterile brands marketed by Manufacturers E and G were also non-sterile in 1931. The other non sterile brand marketed by Manufacturer I was non sterile also in 1933 (see Table II).

THE NEED FOR STERILITY CONTROL

This investigation which involved the bacteriological testing of several thousand of catgut sutures and which extended over a period of 5 consecutive years, has demonstrated the value of the standard bacteriological test proposed by Meleney and Chatfield. When used with the three additional controls and the special neutralizing solutions which I previously reported (2) their bacteriological test has been found to be an efficient and reliable test for the sterility of surgical catgut sutures.

The results of my investigation of the sterility of American made catgut sutures have demonstrated conclusively two important facts: first that in spite of the widespread interest manifested in Meleney's study of catgut sterility and his recommendation for its control there are still being marketed several brands of American made catgut sutures which are non-sterile and second that the need for an adequate control of the sterility of catgut sutures manufactured and sold in America, and which was apparent in 1929 still exists.

In 1931 the American Medical Association appointed a Committee on Catgut Standards for the purpose of studying and recommending a suitable sterility standard and a method of enforcing compliance with such a standard by some established authority. A report from this Committee has not yet been published and non sterile catgut sutures continue to remain a menace to the surgical and hospital professions and to surgical patients, as indicated by the results herein described.

In Great Britain the Therapeutic Substances Regulations prescribe a bacteriological test to which specimens taken from every lot of sutures sold in that country must be submitted. However the Regulations unfor-

tunately do not provide for the use of special neutralizing solutions so that chemically sterilized sutures which are not actually sterile but in which bacterial activity has been inhibited will pass the test. This was demonstrated in my recent research work on the sterility of foreign made catgut sutures (3) wherein I showed that non sterile sutures are being manufactured and sold in England and that similar conditions exist in France Germany Japan and Spain. Hence there is a world wide need for the control of catgut sterility.

In this connection however it should be pointed out that Great Britain following the exhaustive survey of catgut sterility by Bulloch was quick to recognize the importance of controlling the sterility of catgut sutures as evidenced by the prompt enactment of the Therapeutic Substances Regulations of January 17 1930. Much credit is due Great Britain for having been the first country to take such decisive and constructive action toward safeguarding the interests of the surgical and hospital professions. If and when the United States of America adopts a standard test for the sterility of catgut sutures, it should profit by the experience gained as a result of the British Regulations by making the test sufficiently comprehensive to detect chemically sterilized sutures which contain viable bacteria whose activity has been merely inhibited by the chemical treatment. This can be accomplished by incorporating the necessary neutralizing solutions (2) as part of the technique prescribed in the test.

SUMMARY AND CONCLUSIONS

1. During a period of 5 consecutive years including 1930 1931 1932 1933 and 1934 a total of 605 lots comprising 6 184 sutures and embracing twelve brands of American made catgut was subjected to a rigid bacteriological study. The products of Manufacturers A and F were found to be uniformly non-sterile in each of five consecutive years. Two brands, made by Manufacturers E and G were non sterile in 3 consecutive years and then after an interval of 1 year in which they were sterile were again found non-sterile thus being non-sterile in 4 non-consecutive years.

One brand, marketed by Manufacturer I, was non-sterile in 1930, and then, after proving to be sterile in 1931, was found non sterile in 3 consecutive years, thus being non sterile in 4 non-consecutive years. The other non sterile brand, the product of Manufacturer J was non sterile in 2 non-consecutive years (see Table II)

2 Based on the results of this investigation, it seems fair to assume that all catgut manufacturers in America are not using the bacteriological test proposed by Meleney and Chatfield (5), or, if so, they are not employing the special neutralizing solutions recommended (2) as a preliminary step in the technique.

3 Apparently the publication of the results of Meleney's study of catgut sterility has had little or no effect in ridding the market of non sterile sutures, for, during each of the 5 consecutive years since his preliminary report was made, non sterile sutures have been marketed by several American catgut manufacturers.

4. The results of this extensive bacteriological examination of American made catgut sutures carried out over a period of 5 consecutive years, as herein described have proved conclusively that the danger of non sterile

sutures still exists, thus jeopardizing the reputations of the surgical and hospital professions, as well as the welfare and life of surgical patients

5 Adequate control of the sterility of surgical catgut sutures in the United States of America by some recognized authority is of vital importance. It constitutes a serious problem and one with which the surgical profession has been confronted for many years.

BIBLIOGRAPHY

- 1 BULLOCK, WILLIAM. The disinfection and preparation of catgut for surgical purposes. Brit. M. Research Council, London. Special Report Series No 138 Part I, 1929.
- 2 CLOCK, RALPH OAKLEY. The fallacy of chemical sterilization of surgical catgut sutures with particular reference to the use of copper salts, peppermint oil and mercury. Surg. Gynec. & Obst., 1933 56 149.
- 3 Idem. The sterility of surgical catgut sutures with particular reference to foreign made catgut. Surg., Gynec. & Obst. 1934, 59 899.
- 4 MELENEY FRANK L. How can we insure the sterility of catgut? Surg. Gynec. & Obst. 1930, 50 271.
- 5 MELENEY FRANK L. and CHATFIELD MARCEL. The sterility of catgut in relation to hospital infections with an effective test for the sterility of catgut. Surg. Gynec. & Obst., 1931 53 430.
- 6 MELENEY F. L. HOMBERGER, F. B. and CARR, L. An unusual fatal operative wound infection yielding a pathogenic anaerobe of the gas gangrene group. Surg. Gynec. & Obst. 1927 45 775.

THE REACTION OF LIPIDS IN THE BLOOD LEUCOCYTES TO FEVER AND INFECTION

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SOME time ago there was begun in this laboratory a series of investigations on the fat metabolism of the white blood cells. The original purpose was merely scientific, to study variations, if any in the several lipids which might be present in the blood leucocytes under conditions in which the latter are known to change numerically or histologically. As so often happens with research in "pure science" practical applications of the information thus derived become apparent from time to time. In so far as the present investigation has progressed to date it has be-

come more and more obvious that a definite prognostic significance may be attached to lipid analyses of the white blood cells in infective or potentially infective clinical conditions. Data will be presented in the present communication indicating that such is abundantly true in cases of fever. Whether or not the information so obtained warrants the added time and labor involved in the analytical procedure remains to be seen.

The work began with a few observations on the phospholipid content of the blood leucocytes in dogs (3). The method of separating

the leucocytes from blood plasma and the erythrocytes was described in the next paper (5) and is in many respects the most difficult step of the whole procedure. Were it possible to remove a liter or more of blood from men or women and repeat this at intervals of hours or days without any ill effect on the health or physiology of the subject it would be a simple matter to obtain enough white blood cells for lipid analysis—white cells which were entirely free from the last trace of plasma or red cells. Obviously removal of such large amounts of blood is not practical. Even if it were so it is probable that large venesections would of themselves affect the subsequent lipid content of the leucocytes, since hemorrhage is known to produce a marked lipæmia in blood plasma (1).

Since repeated venepunctures were to be necessary in order to follow changes in the leucocytic lipids, it was decided at the beginning of this series of investigations that the method to be adopted should require not more than 50 cubic centimeters of blood. Subsequent analyses have shown that the amount of blood required depends upon the leucocyte count. When the count is 10 000 to 15 000 25 cubic centimeters of blood suffice 15 000 to 25 000 20 cubic centimeters and over 25 000 10 to 15 cubic centimeters. In cases of leucæmia with a white cell count of 100 000 to 400 000 as low as 5 cubic centimeters of blood have been used. The citrated blood is centrifuged and the white cells removed and weighed as previously described (5). No attempt is made to purify the leucocyte fraction for two reasons first, because some of the cells would be lost and the amount of blood stated yields the minimum of leucocytes necessary for analysis and second because washing the cells might dissolve some of their lipids, particularly phospholipid. The white cells thus obtained invariably have traces of plasma and red cells they usually have a slight tan or reddish color. However changes in the lipid content of this fraction of blood have been proved to be due to changes in the leucocytes themselves. This was done by analyzing the lipid content of blood plasma and the red blood cells of the same samples of blood from which the leucocytes were obtained. It was found that

a. The total lipid of the leucocyte fraction was invariably higher than that in plasma or the red cells.

b. The percentage composition of lipids in the leucocyte fraction was different from that in plasma and the red blood cells.

c. Marked increases or decreases in lipid content of the leucocyte fraction were often accompanied by minor changes in plasma and red blood cells frequently changes in the latter two were the opposite of those in the former.

d. In a few cases sufficient blood was available to give samples of pure leucocytes. The fat content of these pure cells was within 5 to 10 per cent of that of the "leucocyte fraction" as routinely used.

For these reasons changes in the lipid content of the leucocyte fraction of blood so obtained are considered to represent changes in the lipid content of the leucocytes themselves. For the same reasons it is felt that the true absolute changes in the white blood cells are even more extensive than have been found by analysis of the leucocyte fraction. Contamination of this fraction with some plasma and red blood cells will tend to depress to some extent the marked changes occurring in the white blood cells. In the few cases in which pure leucocytes were secured the white blood cells were found to contain 5 to 10 per cent more lipids than the leucocyte fraction of the same blood.

A further factor of prime importance to the present investigations was the fact that minute amounts of lipids, as low as half a milligram, may be accurately determined by the recent improved micro-methods of lipid analysis. To W. R. Bloor and his associates go the major honors in the development of these micro-methods. Their technique still requires considerable experience before reliable results are obtained. The study of leucocytic lipids was prefaced by an analysis of the various micro-methods (4). A number of oxidative procedures were tried out, modified, and brought together resulting in the production of a general procedure whereby all the known blood and tissue lipids could be simultaneously determined.

Having developed a suitable method of analysis, the next step was the presentation

a series of tests on the lipid composition of white blood cells in normal individuals (5). No obvious changes were encountered in the white cells of pregnant women (7) although the lipids of blood plasma were all elevated (6). If anything there was a decrease in the leucocytic lipids during pregnancy, particularly in the neutral fat and cholesterol esters (7). Following parturition, however, there was a marked rise in the lipid content of the white blood cells due to an increase in phospholipid, free cholesterol, and neutral fat (7). This change did not appear to bear as direct a relation to lactation as to the involutional processes and repair. In contrast to this, the fall in plasma lipids during the puerperium was directly influenced by activity of the mammary glands. The increase in neutral fat of the white cells was taken to mean a scavenger action by these cells in removing the debris fat of the involuting uterus. The increases in phospholipid and free cholesterol were interpreted as signifying increased activity of the white cells in response to the infective agents at open surfaces.

This introduced a new concept that it was possible to determine the activity of the white cells by measuring their lipid content. As previously reviewed (7, 8) Bloor and his co-workers have shown that activity in a tissue causes an increase in its phospholipid content especially. Bloor has augmented his original studies on this relation in the corpus luteum and endometrium of the sow by showing that the same relation holds in the case of muscular tissue (Bloor and Snider 2).

Following this line of thought the lipid composition of the white blood cells was followed during convalescence from surgical operations (8). It was noted that patients who exhibited a normal healthy postoperative course had a rise in the phospholipid and free cholesterol of the white blood cells. Severe postoperative infections and death were associated with falling values for phospholipid and free cholesterol and large amounts of cholesterol ester and neutral fat. The lipid variation in the former group was indicative of increased activity, in the latter group decreased activity. In conjunction with a recent survey of the lipid changes during fever and convalescence

in blood plasma and the red blood cells, a study has also been made of the variation in the lipid content of the white blood cells. The results to be described bear out the conclusion heretofore noted that the activity of the white blood cells may be determined by lipid analysis. In such a manner it will be shown below that a 'turn for the worse' in fever patients may be predicted several days before clinically apparent. Apart from this practical application, the results are presented for their value in displaying the fat metabolism of the white blood cells during fever.

It will be unnecessary to review here the relation of the present line of work to previous histological and chemical studies on the white cells.

EXPERIMENTAL

The cases to be presented were all female patients most of whom were on the gynecological divisions of the Strong Memorial Hospital. Blood for analysis of the white cells was obtained under fasting conditions, usually in the morning before breakfast. The leucocytes were separated, extracted and analyzed by methods previously described (4, 5).

The series includes a variety of severe fever conditions a number in which the patients recovered normally and several in which the disease was prolonged or death occurred. The different reaction of the white blood cells in these 2 groups will be demonstrated below.

GROUP I—NORMAL RECOVERY FROM FEVER

CASE 1. Mrs. C. B. a 38 year old woman who on September 3, 1933, induced an abortion upon her self following the missing of 2 menstrual periods. Five days later on September 8 she complained of nausea and vomiting, coldness, and lower abdominal cramps. On entering hospital she was found to have a temperature of 38.8 degrees C. with an elevated pulse rate and respiration. No growth was obtained from a blood culture but the urine was positive for *Bacillus coli*. The temperature began to spike and her general condition became serious. Examination revealed an extensive inflammatory reaction in the pelvis with abscess formation and signs of peritonitis. On September 21 and 27 she was given 2 blood transfusions of 500 cubic centimeters each but her condition became worse. Clinically the outlook was grave.

On September 28 a sample of her white blood cells was obtained and analyzed. This revealed a phospholipid and free cholesterol content much higher

than the average normal, suggesting that she had a good response to infection by her white blood cells. Hence it was decided to perform a posterior colpotomy and relieve the pressure of pus in the pelvis.

The response to operation was striking. Her fever immediately subsided and she rapidly improved. A second analysis of the white blood cells was performed on October 3, the fourth day after operation, and a third on October 14. At the latter date she was well on the road to recovery; there was no drainage from the colpotomy tube and Dakin's irrigations returned clear fluid.

The following values were found on analyzing the white blood cells. For convenience the various lipids determined will be indicated by the following symbols—total lipid, T.L. total fatty acid T.F.A. neutral fat N.F. total cholesterol, T.C. ester cholesterol, E.C. free cholesterol, F.C. phospholipid, P.

Date	T.L.	T.F.A.	N.F.	T.C.	E.C.	F.C.	P.
Sept. 28	1,403	784	40	366	18	1,186	2003
Oct.	1,508	960	130	508	308	201	700
Oct. 14	123	780		518	415	403	330

It may be seen that analyses of the white blood cells in this case revealed information of much value in determining the prognosis and treatment. On September 28 the patient appeared on the verge of death and clinically it was impossible to tell whether opening the pelvis would relieve her symptoms or hasten death. At that time the leucocytes were found to have activity greater than normal according to their lipid analysis. The phospholipid content was over 1,000 milligrams per cent the free cholesterol was 248 milligrams per cent contrasted to 100 for normals, neutral fat was low—40 milligrams per cent (normal around 500) and ester cholesterol was not elevated. The significant value was the high phospholipid which always indicates increased activity. Active tissue usually also contains increased amounts of free cholesterol and low values for ester cholesterol and neutral fat, and these added features also characterized the leucocytic lipids on September 28.

Hence it could be said from the lipid analysis that this patient had a good resistance to infection and that the symptoms were due to the mass of the infecting organisms present. When this was relieved by a posterior colpotomy the active leucocytes rapidly overcame the remaining organisms. The analysis

of October 2 a few days after operation indicated a further increase in the activity of the white cells as evidenced by a rise in phospholipid and free cholesterol. During convalescence on October 14 the leucocytes still contained large amounts of these 2 lipids.

CASE 2. Miss A. C. a 26 year old negro, gave a history of having had an abortion, complete about 3 weeks previous to admission to hospital, on a pregnancy of about 6 weeks duration. She developed a fever and pain in the lower abdominal region, and on examination was found to have large, tender masses in the pelvis. Her blood Wassermann was 1+ white cell count 22,300 (88 per cent polymorphonuclears) and she had a temperature of 38.5 degrees C.

On February 8, 1934, 1 week after admission, her white blood cells were analyzed and found to contain elevated values for phospholipid and free cholesterol and small amounts of ester cholesterol and neutral fat. With this evidence of increased leucocytic activity the prognosis was good. However the abscess failed to point quickly and the temperature kept rising each afternoon. On February 13 the analysis was repeated with essentially the same results. A posterior colpotomy was performed on February 17 and, as in Case 1, the patient immediately improved.

The following values represent the results of the lipid analysis:

Date	T.L.	T.F.A.	N.F.	T.C.	E.C.	F.C.	P.
Feb. 8	1,605	918	20	317	57	270	2000
Feb. 13	1,264	790	24	308	30	249	890
Feb. 20	100	130		615	108	500	1200

The results of this case are practically identical with those of Case 1. Throughout the febrile period the white blood cells contained more phospholipid and free cholesterol and less neutral fat and ester cholesterol than the average normal. Thus although the patient appeared to have a severe infection her response to operation was immediately favorable. During early convalescence there occurred a further rise in the leucocytic phospholipid and free cholesterol.

CASE 3. Mrs. A. F. a 43 year old woman, entered hospital a convalescent from scarlet fever complaining of lower abdominal pain. Examination revealed the presence of a large abscess in the cul-de-sac of the pelvis. Her temperature varied between 37.5 and 39 degrees C. with an elevated pulse and respiration rate and a marked leucocytosis, 49,300 (83 per cent polymorphonuclears). The patient appeared very sick.

A sample of the blood leucocytes was obtained on February 5, 1934, in the morning just before a drainage tube was inserted through the posterior wall of the vagina. Three days later, on February 8 a second analysis was performed as the patient's temperature had fallen somewhat although she did not appear to have improved otherwise her white cell count had fallen to 14,000. On February 14 the patient was much better her temperature was practically normal, there was very little drainage from the pelvis and the white count was 19,300.

The following lipid values were obtained

Date	TL	TFA	NF	TC	EC	FC	P
Feb 5	1517	870	33	75	0	250	1.20
Feb 8	1426	78	23	203	0	31	1.40
Feb 14	1435	1200	53	52	0	573	850

This case again illustrates a severe fever with leucocytes possessing greater than normal activity according to their lipid content and distribution. The patient did not make as rapid a recovery from opening the pelvic abscess as might have been expected from the lipid values. The analysis of February 8 revealed that no decrease had occurred in the phospholipid and free cholesterol fractions and the trouble was eventually found to be an imperfect drainage. When this was corrected the patient quickly recovered. The analysis of February 14 demonstrated a marked rise in phospholipid and free cholesterol.

CASE 4. Mrs. A. F., a 31 year old woman entered hospital with an infected abortion upon a pregnancy of a few weeks duration. While in hospital her temperature suddenly rose and was found due to the presence of a pelvic abscess. On the second day of fever, February 2, 1934 a posterior colpotomy was performed from which the patient made a surprisingly rapid recovery. Lipid analyses were done on the day of operation when the patient had a temperature of 38.4 degrees C. and on the fifth and seventh days of the convalescence when the temperature was down to normal with these results

Date	TL	TFA	NF	TC	EC	FC	P
Feb 2	1664	1000	370	330		113	0.65
Feb 6	9609	323	74	660	20	648	185
Feb 13	2943	1590	06	590	8	35	40

Case 4 coincides with each of the cases cited. Although she developed a severe febrile reaction from the presence of pus in the pelvis her blood leucocytes contained large amounts of phospholipid and free cholesterol. When the

pressure of pus was relieved through drainage, phospholipid the index of tissue activity, more than doubled in value. The increase in the activity stimulating lipids was immediate following establishment of drainage and the patient as a result rapidly recovered.

CASE 5. Mrs. M. N. a 20 year old woman, at term in pregnancy, was admitted to hospital in active labor. She had not attended the prenatal clinics and was found to have a markedly contracted pelvis after labor had progressed without results. On February 1, 1934 a low cesarean section was performed following which her temperature rose to 39.2 degrees C. and remained so for 2 weeks with the patient in a serious condition. She received 3 blood transfusions of 500 cubic centimeters each.

On February 8 a lipid analysis was performed with the patient's temperature at 38.5 degrees C. and the white count 26,200. The results showed values for phospholipid and free cholesterol in the lower range of normals and much less than would be expected at this stage of the puerperium from previous analyses of normal puerpere (7). A second analysis was made on February 16 and this indicated a rise in the lipids associated with activity phospholipid, and free cholesterol. Shortly after this the fever subsided and the patient made an uninterrupted recovery. The lipid values obtained were

Date	TL	TFA	NF	TC	EC	FC	P
Feb 8	76	585	73	253	80	208	597
Feb 16	145	826	43	212	0	231	1.70

This case has been presented as an example of changes in the leucocytes during puerperal sepsis. In a normal woman there occurs a marked rise in the phospholipid and free cholesterol of the white blood cells a few days after parturition (7). In Case 5 these lipids were not elevated as would be expected indicating that the white blood cells in this patient did not at first respond to the infective process by increased activity. Fortunately for the patient no organism of marked pathogenicity was present blood cultures were negative and the urine contained only *Bacillus coli*. In the beginning of the third week of the puerperium the leucocytes were found to have increased phospholipid and free cholesterol over their values at 1 week postpartum. This indicates that the white cells did eventually respond with increased activity and the patient recovered.

CASE 6. Mrs. E. C. a 40 year old woman developed a cystitis and pyelitis in conjunction with

severe uterine bleeding. The menorrhagia was found, after investigation, to be due to endocrine dysfunction. She had an elevated temperature of 38.8 degrees C with a rapid pulse and respiration. The fever lasted a few days but quickly subsided under the usual treatment of rest in bed and forcing fluids. Only 1 lipid analysis was performed on this patient at the height of fever.

TL	TFA	NF	TC	EC	FC	P
57	383	95	4.90	66	37	1.20

The results indicate an excellent response by the white blood cells to the infection of the bladder and renal pelvis. It was quite rational to predict that the patient would make a rapid recovery which she eventually did.

CASE 7. Miss G. K., a 31 year old woman treated for agranulocytic angina. This patient exhibited a pronounced tendency toward a leucopenia each time she menstruated and during these periods was especially liable to infection. A sample of blood was obtained before one of these periods to determine whether or not there was a disposition to inactivity on the part of the blood leucocytes. The following values were obtained:

TL	TFA	NF	TC	EC	FC	P
3	847	399	16	3	20	6.8

Very little can be positively stated about this analysis except that the phospholipid content was in the low range of normals. The remaining values are near the means for healthy persons. This much can be said however that the white cell count in this patient was low and was associated with no increase in the activity of the leucocytes present. Hence the total resistance to infection of this patient decreased greatly during periods of leucopenia.

CASE 8. Mrs. H. P., a 30 year old woman was admitted to hospital 8 months pregnant with evidence of failing heart action consequent upon a rheumatic heart disease. On entering the obstetrical division she complained of dyspnea, pain over the precordium and oedema of the extremities. Her blood pressure was 160 systolic and 60 diastolic and the urine contained 1+ albumin and casts. The white blood cell count was 7,550.

On February 14, 1933 a Porto-caesarean section was performed under nitrous oxide and ether anesthesia. Following the operation, her temperature rose to 38 degrees C and she had some pain and distention in the abdomen. The white cell count rose to 17,550 of which 91 per cent were polymorphonuclear leucocytes. The patient's temperature

subsided in about a week, she recovered, and was discharged from the hospital 3 weeks after operation.

Samples of blood for lipid analysis were secured before operation and on February 17, 3 days after delivery in the midst of the febrile reaction.

Date	TL	TFA	NF	TC	EC	FC	P
Feb. 9	603	234	27	165	6	39	37
Feb. 17	74	263	260	4.75	240	1.26	601

The lipid analysis of February 9 depicted the blood leucocytes as containing small amounts of all lipids, a condition characteristic of the leucocytosis of pregnancy as described. The response to caesarean section and postoperative fever however was quite favorable. Phospholipid was increased more than 6 times while free cholesterol was doubled. When such a change occurs, it has been found that variation in neutral fat and ester cholesterol should not be considered in computing the activity of the white blood cells. The increase in phospholipid alone is sufficient to denote an increase in activity of the white blood cells. As a result of this augmented resistance to infection the patient quickly recovered from the postoperative infection.

GROUP II—FEVER FOLLOWED BY COMPLICATIONS OR DEATH

CASE 9. Mrs. E. M., a 37 year old woman, was admitted to hospital with a high fever and a history of self induced abortion. On examination she was found to have a parametritis and pelvic abscess with signs of pelvic peritonitis. Her temperature was 39.8 degrees C, pulse rate 125 and respirations 30. Clinically the patient appeared similar to Cases 1 to 4 above. Analysis of the white blood cells revealed an entirely opposite state of affairs to the cases in Group I. The most important value again was phospholipid which was very low—300 milligrams per cent. Blood for lipid analysis was obtained just before a posterior colpotomy was performed in the hope of relieving the pus collection in the pelvis.

Following this operation the patient did not improve. Her temperature went even higher, she became irrational, and in a few days she died. The lipid analysis of the blood leucocytes just before operation yielded the following results:

TL	TFA	NF	TC	EC	FC	P
540	238	40	20		5	300

The important feature of this analysis is the extremely low value for phospholipid in spite of the marked fever. As already stated, low

values for phospholipid characterize inactive and degenerating tissue. It is obvious in this case that the response of the white cells to infection was very feeble. And it may be noted that no organisms of marked pathogenicity, such as hæmolytic streptococci, were found.

CASE 10. Mrs. T. P. A 34 year old woman was brought to hospital with fever and a muttering delirium. According to her husband she was about 6 weeks pregnant and had an abortion induced upon her a few days previous to entering hospital. The patient had a temperature of 40.2 degrees C, pulse rate of 150, respiratory rate of 37 and a white count of 6,400 (88 per cent polymorphonuclears). She had obvious signs of peritonitis and blood culture revealed the presence of 250 hæmolytic streptococci per cubic centimeter.

A sample of blood was obtained shortly after admission to hospital and several hours later the patient died. The following values were noted for the leucocyte lipids.

TL	TFA	NF	TC	EC	FC	P
1285	605	0	635	506	70	45

There are several features which mark these cells as being extremely inactive or degenerate. First, the level of phospholipid as in Case 9 is very low—410 milligrams per cent for a patient with a marked fever. Free cholesterol was also low—129 milligrams per cent—while the leucocytes contained large amounts of ester cholesterol—506 milligrams per cent. The high value for ester cholesterol suggests particularly degenerate cells. The response of the blood leucocytes to infection was evidently nil and the patient died.

CASE 11. Mrs. T. F. A 21 year old woman, who entered hospital complaining of swelling and pain in her legs. She gave a history of having been delivered of a full term child about 6 weeks previous. In hospital she was found to have a temperature spiking from about normal in the morning to 40.5 degrees C in the afternoon. The left leg was swollen, hot, and tender especially along the subcutaneous veins. A diagnosis of thrombophlebitis was made and the patient put on the usual treatment of rest in bed with elevation of affected leg and ice packs.

On February 2, 1934, a few days after admission blood culture revealed the presence of 90 hæmolytic streptococci per cubic centimeter of blood. The patient was transferred to the isolation ward and given repeated small blood transfusions of 250 to 300 cubic centimeters every other day. On February 7 the first sample of blood was obtained for lipid analysis. The white cell count remained low as at the beginning, varying between 6,000 and 8,000.

On February 13 a second sample of blood was secured in conjunction with a blood culture test. The latter revealed fewer organisms per cubic centimeter of blood but the patient's temperature continued to rise and fall as before—the typical 'spiking' temperature curve of blood infection.

The third lipid analysis was performed on blood obtained before transfusion on February 15. A fourth sample of blood was taken just after transfusion had been completed, the object being to see if the donor's blood had any immediate effect on the lipids in the leucocytes of the patient. The analysis for this latter blood is the second recorded on February 15 (b). On this day the patient appeared slightly better clinically.

A few days later another relapse set in and a thrombophlebitis developed in the other leg. On February 19 the fifth lipid analysis was done and on the same day the blood culture was reported negative. Shortly after the patient developed a subphrenic abscess and several abscesses in the legs. All of these were opened and drained and the patient eventually became afebrile and recovered.

This case is in many respects remarkable as being a patient with a hæmolytic streptococcus infection of the blood who eventually recovered. The lipid analyses of the white cells were extremely interesting.

Date	T.L.	TFA	NF	TC	EC	FC	P
Feb. 7	1258	8500	2060	70	170	71	827
Feb. 13	902	1560	851	187	0	254	751
Feb. 13(a)	948	590	113	183	0	100	423
Feb. 13(b)	836	45	20	11	0	213	406
Feb. 19	1773	920	0	183	0	380	500

The phospholipid content of the white blood cells in the initial stages of the infection were within normal limits and indicated a fair degree of activity on the part of the blood leucocytes in response to infection in spite of the low white cell count. A peculiar feature of these early analyses was the presence of large amounts of neutral fat. Whether or not this had any connection with the formation of thrombi in the veins is not known. The white cells separated from blood had a peculiar sticky or gummy consistency. The cells on February 15 may be seen to have lost much of their phospholipid and free cholesterol. It was shortly after this that thrombophlebitis developed in the other leg and the patient became clinically worse. Nevertheless a sample taken 1 or 2 days after this on February 19, exhibited a sharp rise in phospholipid and free cholesterol. From then on the patient passed

into a stage of abscess formation and eventually recovered.

The effect of blood transfusion is indicated in the lipid analyses performed before and after transfusion on February 15. It may be seen that healthy blood from the donor produced a slight increase in phospholipid and free cholesterol and a more marked decrease in neutral fat. These variations indicative of increased leucocyte activity confirm the clinical observation that repeated small blood transfusions are beneficial in septicemia.

CASE 12. Mrs. A. B., a 36 year old woman, was admitted to the medical division of the Strong Memorial Hospital with a marked fever. She was known case of chronic lymphatic leukemia and on examination was found to have a lobar pneumonia. Her temperature varied around 39 degrees C. with a pulse rate of 120. Blood examination revealed 55,000 white blood cells per cubic centimeter, 95 per cent of which were lymphocytes. The non protein nitrogen of the blood was 36 milligrams per cent and her blood Wassermann was negative.

A sample of blood for lipid analysis was obtained on March 24, 1934, through the courtesy of Dr. D. J. Stephens of the medical department. The lipid composition of the white blood cells was

IL	TLA	NF	TC	FC	PC	P
		95			1	475

The analysis indicated that the patient had a very low response to infection. The white blood cells contained small amounts of phospholipid and free cholesterol. It was later learned through Dr. J. S. Lawrence of the medical department that this patient died shortly after the above lipid analysis was performed. Such an issue was eminently predictable from the lipid analysis of the white blood cells.

In each of the cases just described the one substance which exhibited the most striking the most constant and the most significant changes was phospholipid. Increased activity of the white blood cells was always accompanied by rising or high values for phospholipid. A patient with an infection and a phospholipid content of around 1,000 milligrams per cent or higher in the white blood cells may be said to have developed an active resistance to infection and an excellent chance of recovery. If the phospholipid value is below 500

milligrams per cent in spite of the stimulus of infection then the outlook is definitely grave.

The use of this method as a means of measuring the activity of the white blood cells is thus really a functional and not a static test. What we are determining is the response of the blood leucocytes to infection, operation, parturition, etc., etc., by analyzing for an increase or decrease in the phospholipid fraction. For this reason repeated analyses are of more value than single determinations, especially where we wish to follow changes in the activity of the white cells from time to time throughout a prolonged illness.

From the results of this and previous communications it has become definitely established that to estimate the functional activity of the blood leucocytes the only substance which need be determined is phospholipid. Determination of the other fatty substances as already listed will supplement the information derived from phospholipid analyses but is not necessary. Hence the test as now used routinely in this clinic consists in the determination of the phospholipid content only of the white blood cells.

Determination of the phospholipid content of the white blood cells may be performed on a sample of blood within a few hours. If the blood is obtained in the morning before breakfast the test may be completed in the early afternoon and does not require the continuous attention of the analyst. It does require some technical experience as do all micromethods for lipid analysis.

The procedure may be briefly outlined here. For more detailed information the previous papers, discussed here, may be sought. Blood is centrifuged, the plasma drawn off and the white cell layer lying on top of the red blood cells, removed with a pipette or pair of forceps. This is quickly weighed, ground up with clean sand and alcohol ether 3:1 added with shaking. The residue is filtered off and discarded. The alcohol ether extract is then evaporated to dryness and the residue extracted with petroleum ether. From the petroleum ether extract the phospholipids are precipitated with acetone and magnesium chloride. The precipitate is dissolved in moist ether and transferred to glass stoppered flasks,

the solvent evaporated off and the remaining phospholipid residue oxidized completely with chromic acid. From the amount of chromic acid thus required the amount of phospholipid present may be calculated.

SUMMARY

The results of the present investigation in conjunction with previous reports demonstrate that the white blood cells undergo marked metabolic variations as indicated by changes in their lipid content in pregnancy, lactation, postoperative convalescence, fever, and convalescence from fever. The present report contains 26 complete differential analyses of the lipids in the leucocytes under fasting conditions in 12 cases of fever. In each analysis the lipids determined were free cholesterol, ester cholesterol, total cholesterol, phospholipid, neutral fat, total fatty acids, and total lipid. Oxidative micromethods were used.

The findings were grouped according to whether or not the resistance of the patients was sufficient to overcome the infection. In patients who recovered normally from fever due to a variety of causes, the white blood cells contained large amounts of phospholipid. There was generally also an increased value for free cholesterol with low figures for ester cholesterol and neutral fat. In these convalescence was accompanied by a further rise in phospholipid.

On the other hand, patients who died as a result of their infection were noted to have low phospholipid values in the blood leucocytes during the febrile period. The same was found true in a case of thrombophlebitis when complications developed.

From this evidence and previous data it has become obvious that the activity of the white blood cells may be measured by determining their lipid content, especially the phospholipid fraction.

Data from one case suggests that a blood transfusion may increase the activity of the white blood cells.

REFERENCES

1. BLOOR W. R. Lipemia. *J Biol Chem* 1921 49: 201.
2. BLOOR, W. R. and SMITH, R. H. Cell lipids and function in muscle. *Proc Soc Exper & Biol Med* 1934 31: 836.
3. BOYD E. M. Low phospholipid values in dog plasma. *J Biol Chem* 1931, 91: 1.
4. Idem. A differential lipid analysis of blood plasma in normal young women by micro-oxidative methods. *J Biol Chem* 1933 101: 343.
5. Idem. The lipid content of the white blood cells in normal young women. *J Biol Chem* 1933 101: 623.
6. Idem. The lipemia of pregnancy. *J Clin. Invest.* 1934, 13: 347.
7. Idem. The lipid composition of the white blood cells in women during pregnancy, lactation, and the puerperium. *Surg Gynec & Obst* 1934 59: 744.
8. Idem. The post-operative activity of white blood cells as measured by their lipid content. *Canadian M Ass J* 1934, 31: 676.

CLINICAL SURGERY

FROM THE WILLIS C CAMPBELL CLINIC

AN OPERATION FOR REPAIR OF THE INTERNAL AND EXTERNAL LATERAL LIGAMENTS OF THE KNEE JOINT

WILLIS C CAMPBELL, M D F A C S MEMPHIS, TENNESSEE

THE ligaments of the knee joints have certain well known functions to perform and when they are mechanically impaired by complete or partial rupture or elongation more or less disability may result. Definite lateral instability from elongation or stretching of the lateral ligament, and also definite anterior posterior instability from impairment of the crucial ligaments, are consistent with an apparently normally functioning knee. However such a knee is obviously more prone to injury from trauma than one not so affected. There are many instances in which ligament impairment does cause definite symptoms and disability which may be independent or associated with injuries of the semilunar cartilages or other derangements. There are also instances in which disability persists after removal of a cartilage which is due to rupture or elongation of ligaments. The lateral ligaments may be come relaxed following either acute trauma or repeated injury as may occur after recurrent displacements of the cartilage or other internal derangements.

When the cartilages are involved well known classical symptoms will be found. When there

has been stretching or elongation of the internal lateral ligament tenderness will be present along the attachments of the ligament or at any point where rupture may have occurred and symptoms of indefinite internal derangement and a feeling of instability may be noted. The same symptoms may be present on the outer aspect when the external lateral ligament is involved.

To determine lateral stability of the knee the joint is completely extended, the leg is then grasped by one hand just above the ankle while the other hand fixes the thigh. No motion will be present in a normal knee. If the internal lateral ligament is impaired, however excessive abduction will be possible. If the external, excessive adduction. Certain apparently normal individuals have hypermobile joints, in which case there may be more or less lateral motion present—an abnormality which can always be determined by comparison with the opposite knee.

The internal ligament is much more frequently involved than the external in fact I have never seen a rupture of the external ligament requiring surgery.

The same procedure can be used to repair either or both sides, when indicated, but as the internal ligament is the more frequently involved we shall describe the treatment as applied to impairment of that ligament. The technique is as follows:

A skin incision is made parallel with the quadriceps tendon the patella and patellar tendon from 2 or 3 inches above the patella to just below the tibial tubercle. The deep fascia is incised and the capsule exposed. A curved incision parallel with the patella and the upper surface of the tibia is made into the knee joint if internal impairment is suspected and such attention given as may be required, after which the joint is closed. The repair of the ligament is accomplished by dissecting from the inner aspect a strip of fascia lata about 0.5 inch in width and 4 inches in

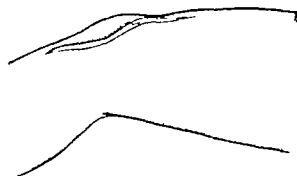


Fig. 1 Internal incision parallel to patellar tendon, which gives access to joint and also to internal lateral ligament.

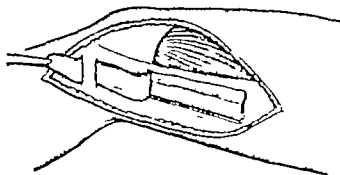


Fig. 2. Dissection of flap which is placed through tunnel down to the joint beneath the soft structures

length from above down to a point about opposite the center of the inner aspect of the internal condyle of the femur. Two parallel incisions about 1 inch in length and about 0.5 inch apart are next made through the deep fascia and periosteum, about 1 inch below the upper extremity of the tibia and parallel with the joint line. An artery forceps is then passed through the lower incision close to the knee, emerging through the upper incision. The upper end of the fascial flap is grasped by the forceps and brought through the tunnel in the dense fascia and periosteum. After this the ligament is drawn tight and stitched as

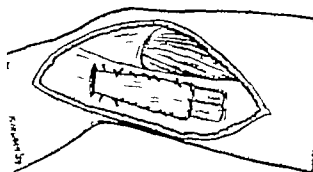


Fig. 3. Flap drawn very taut through tunnel and stitched in place, thus tightening the relaxed ligament.

high as possible to the margin of the fascia lata from which it has been dissected. The limb is held extended and forcibly adducted during the operation. By passing the fascia through the tunnel a very accurate pulley action can be made, which permits effective tightening or tautness of the capsule.

This operation has been used when there has been undue laxity of the ligament associated with injury of the cartilage, and also when there has been no cartilage impairment. The procedure has been employed for the past 2 years, and so far the results have been excellent in 3 cases.

THE SURGICAL TREATMENT OF TUBERCULOUS EMPYEMA¹

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BY "tuberculous empyema" is understood a collection of pus in the pleural sac, wherein the primary causative agent is the tubercle bacillus. Frequently however various other pyogenic organisms become associated and a resulting secondary infection is superimposed.

CLASSIFICATION

From the standpoint of surgical treatment two main groups may be recognized: (1) tuberculous empyema, (2) tuberculous empyema with secondary infection.

Hedblom and other writers divide the tuberculous form into two types: (1) primary without clinical evidence of associated pulmonary tuberculosis, (2) secondary where there is a clinically recognizable active pulmonary lesion.

The decision to apply surgical treatment is determined in the main by the condition of the underlying lung. In a classification based as primary or secondary, it is difficult to assess with accuracy the amount of lung involvement. The presence of a large pleural effusion, whether seropurulent or purulent, makes X-ray diagnosis of the pulmonary lesion often impossible. Tuberculosis limited to the pleura is generally accepted as being of rare occurrence and one must also remember that an extension of a tuberculous lesion in the lung may occur subsequent to the development of the empyema.

Archibald recognizes a seropurulent and purulent form of the tuberculous type. While the degree of infection is of much importance in that the purulent is invariably a further stage of the seropurulent form denoting also in some cases a more serious infection, the indications for surgical interference remain unaltered.

In the group of tuberculous empyemata with secondary infection, there are present added indications for surgical treatment which do not pertain to the tuberculous group *per se*. These indications may be such as have caused the mixed infection, e. g. bronchial fistula or external drainage, fixation of the cavity due to a greatly thickened pleura or long standing toxemia.

DIFFERENTIATION

It is all important that a tuberculous empyema be differentiated from one of purely pyogenic origin. Seropurulent or purulent fluid aspirated from the chest and found to contain no pyogenic

organisms should be considered tuberculous. The writer has had the experience of one case where the fluid was repeatedly sterile in aerobic culture but anaerobically gave a pure culture of *Brucella abortus*. This case, to his knowledge is the only instance of an empyema resulting from such infection and while not of frequent occurrence with the increasing incidence of undulant fever this possibility must be borne in mind. The diagnosis rests in the examination of the aspirated fluid for tubercle bacilli, guinea-pig inoculation or microscopic examination of the excised pleura in patients operated upon. Repeated examination of the fluid as well as animal inoculation may fail to demonstrate tubercle bacilli. One must then rely on other criteria to establish a diagnosis. If there is sufficient evidence to show that an insidiously developing primary pleural effusion preceded the empyema, it should be regarded as tuberculous. This fact is now generally accepted. The finding of tubercle bacilli in the sputum is presumptive evidence that an accompanying empyema is tuberculous. Empyema developing from serous effusions, the result of pneumothorax treatment, or in the presence of active pulmonary tuberculosis, may also be considered tuberculous. Too much care cannot be taken to establish a proper diagnosis as the entire future treatment depends on so doing.

Several of our cases were admitted after a rib resection with a history somewhat as follows:

"Patient is taken ill with infection in the chest and a diagnosis of pneumonia is made. After a variable length of time signs of effusion appear. Aspiration is performed and a thin, cloudy fluid withdrawn. The temperature remains elevated, the patient is quite ill and the fluid reaccumulates. Aspirations are repeated each time perhaps the fluid is found to be slightly more purulent. No culture is made. The case is considered one of empyema following pneumonia, probably of the influenza type and a rib resection is performed.

The condition however may be an acute tuberculous infection, with effusion. The rib resection precludes the possibility of a cure by other than prolonged treatment and surgical measures. Whatever chance the patient may have had of overcoming his infection with an expanded lung is denied by the unjustifiable and ill considered external drainage. Alexander says, the keynote of treatment is that open drainage must never be instituted, and Keller states that over 50 per cent of tuberculous empyema at the Walter Reid

¹Read at the annual meeting of the Saskatchewan Medical Association, Regina, Sask. August 26, 1933.



Fig. 1

Fig. 1. Case 1. A. M. Condition on admission. Acute tuberculous infection with effusion, secondarily infected by rib resection. Contralateral lung clear.



Fig. 2

Fig. 2. Case 1. A. M. After 6 months treatment with irrigation. No reduction in size of cavity.



Fig. 3

Fig. 3. Case 1. A. M. Condition on discharge. Obliteration of cavity following complete costectomy in four stages. Small sinuses injected with bismuth. This later closed.

Hospital had had previous open drainage the greatest tragedy that could befall them.

It is recognized that tuberculous patients do not tolerate an open pneumothorax. More particularly is this true in the early stages. In any case with pus in the pleural sac, surgery should not be considered until a thorough bacteriological examination of the aspirated fluid has been completed. Rarely, if ever does a chest full of pus constitute a surgical emergency. Embarrassing pressure symptoms or toxæmia can be adequately relieved by aspiration. Microscopic study and culture will readily demonstrate the presence of pyogenic organisms and no case should be subjected to drainage where bacteriological examinations have been negative.

TREATMENT

Marked absence of agreement seems to prevail as to which cases should be treated conservatively and which should be referred to the surgeon for some form of collapse.

In Saskatchewan sanatoria prior to 1925 all patients were treated by aspiration with or without air replacement by injection of antiseptics, and when secondarily infected by open drainage. Hamilton, of the Saskatchewan Anti Tuberculosis League reviewed all cases definitely proved as tuberculous over a period of years and found that in the severe mixed infection type with bronchial fistula 13 in all, 10 died, 9 of the empyema, 1 of progressive pulmonary disease. Where rib resection had been done either before or after

admission, 13 in all, 1 was well after 5 years of treatment. The remaining 12 died.

The present report includes 6 cases of the severe mixed infection type in which bronchial fistulae were present at time of operation and which were treated by thoracoplasty. These were discharged from hospital with bronchial fistula closed and cavity obliterated. There were 8 with external drainage on admission; all were treated by thoracoplasty. Two patients on discharge had small sinuses in the remainder complete obliteration of the cavity was obtained.

In tuberculous empyema complete re-expansion of the lung may not be possible because of thickened pleura or parenchymal fibrosis; moreover it may not be desirable on account of the danger of lighting up disease within the lung. Consequently, obliteration of the cavity can be obtained only by some form of surgical collapse, mobilizing the rigid chest wall so that symphysis of pleurae becomes possible.

In considering the form of collapse the procedure is determined by the size and extent of the cavity. Decortication of the lung must not be considered because of underlying tuberculous disease. Hedblom reported 4 cases in 1922 in which he had performed decortication, the diagnosis being made subsequent to the operation by microscopic examination of the excised pleura. In 3 cases partial obliteration of the cavity resulted; 1 patient died of hæmorrhage.

The disability resulting from surgical collapse varies with the extent of the operative procedure.



Fig 4

Fig 4 Case 3 M U Shows empyema cavity right side 3 1/2 years after onset. Intervening treatment of aspiration and irrigation subsequent to cessation of treatment developed empyema necessitatis with anterior sinuses.



Fig 5

Fig 5 Case 2 M U Shows size of empyema cavity 9



Fig 6

months after complete posterior thoracoplasty. Cavity filled with hyaloid.

Fig 6 Case 5 M U Condition on discharge. Cavity completely obliterated following unroofing operation on residual cavity.

It is considerable where the cavity is large necessitating a complete thoracoplasty. Vital capacity is lowered. There is the usual operative risk and a certain amount of mutilation and deformity commonly result. The risk is not great provided graded operations are employed and provided the general condition of the patient is moderately good.

In addition to the usual pre-operative preparation, the routine treatment at the Saskatoon Sanatorium where the cases under review were operated on, is especially directed to minimizing as much as possible pulmonary complications, the result of upper respiratory infections. Some time prior to operation all loose teeth are extracted and carious teeth treated or filled. Special attention is paid to pyorrhea and gingivitis. The day preceding operation, a thorough antiseptic toilet of mouth, nose and throat is carried out by careful cleansing of the teeth, nasal douches, and throat gargles. This is repeated twice on the morning of operation. The same morning the patient is encouraged to empty the lungs of all sputum, first upon awaking and again when the hypodermic is given. In operative chest cases the basal metabolic rate is ascertained and vital capacity estimated. Blood urea is determined, as is also coagulation and bleeding time, and kidney function is appraised by the Mosenthal test. The anesthetic employed has been novocain 1/4 per cent combined with nitrous oxide gas and oxygen.

a Tuberculous empyema. Where there is little or no evidence of lung involvement and the fluid is seropurulent in character the treatment is the same as for a purely serous effusion. Aspiration should be resorted to only when pressure symptoms have developed or when the fluid fails to be absorbed after a reasonable period of time. When it is definitely purulent and present in large quantity, early and repeated aspiration seems to give the best results. Hamilton, of the Saskatchewan Anti-Tuberculous League, reports favorable results from aspiration and irrigation with replacement of air but that treatment should be early and frequent to prevent serious complications such as bronchial fistula or sinus in the chest wall. If however there is much underlying lung involvement, increased pleural thickening, lack of improvement in the patient's condition, or if after repeated aspirations the cavity remains undiminished, thoracoplasty should be considered.

b Tuberculous empyema with mixed infection. The mildly infected cases, without bronchial fistula or open drainage should be treated the same as the sterile group. If the toxemia is marked, drainage must be resorted to. If open drainage has been performed, further surgical procedure must be considered just as soon as the patient's condition warrants. If the infection is of long standing further reduction in the size of the cavity cannot be expected. Six cases in this



Fig. 7



Fig. 8



Fig. 9

Fig. 7 Case 3 J. S. Large empyema cavity on admission.

Fig. 8. Case 3. J. S. Shows size of cavity following posterior extrapleural thoracoplasty

Fig. 9 Case 3 J. S. Shows size of cavity after total costectomy. Roentgenogram taken 2 weeks after the fourth stage operation.

series were admitted with open drainage and in none was any appreciable diminution in the size of the cavity obtained by irrigation. Occasionally, however, after open drainage and irrigation the secondary infection is overcome and the sinus closes, with resulting clear sterile effusion. This occurred in one of our cases. If bronchial fistula develops, open drainage is indicated to be followed later by surgical collapse. In 1 case with a long standing bronchial fistula, an attempt was made to obliterate the cavity by thoracoplasty postural drainage and aspiration before and after operation being depended upon to keep the cavity evacuated. Total thoracoplasty in four stages preceded by phrenic avulsion was performed. A residual cavity of some considerable size persisted, requiring drainage, unroofing and muscle transplantation before a final closure was obtained. In such cases open drainage should be instituted prior to or during the first stage of thoracoplasty, through a small dependent opening well away from the operative field. In the acute stage after drainage Archibald counsels waiting until the patient shows evidence of overcoming the infection before undertaking further surgical procedure.

The following is a case report of a severe mixed infection, complicating an acute tuberculous effusion

CASE 1. A. M. an English male farmer aged 24 years, in March, 1930, developed pain in right chest and non-productive cough. He felt feverish but continued to work. Dyspnoea developed and he was forced to go to bed 3 weeks

after onset with a temperature of 103 degrees. The chest was aspirated and 3,000 cubic centimeters of cloudy fluid was withdrawn. No bacteriological examination of fluid was made. He was admitted to the hospital and rib resection was carried out on April 1, 1930. He had lost 15 pounds in weight, night sweats were present and a small amount of sputum. His condition following rib resection grew worse and he was transferred to the Saskatoon Sanatorium on April 17, 1930, with a temperature of 103.5 degrees, pulse 140, respirations 24-28. On April 19, a further rib resection was performed to permit of more dependant drainage. Daily irrigations with Dakin's solution were carried out and for several weeks there was no improvement. During this period the temperature varied, 103 to 105, pulse 130 to 160, respirations 24 to 48. Guinea-pig inoculation of the chest fluid was positive for tubercle



Fig. 10 Case 3 J. S. Three months later. Cavity completely obliterated.



Fig 11

Fig 11. Case 4. Condition on admission February, 1926. Right parenchymatous tuberculosis throughout with ca. station. Left lesion in first and second interspaces.



Fig 12

Fig 12. Case 4. A. B. Right, empyema with bronchial



Fig 13

fatula, 4 1/2 years after conservative treatment. Left, lung now clear.

Fig 13. Case 4. A. B. After complete extrapleural thoracoplasty in four stages. Left lung exchanged.

bacilli. From July 1, November there was slow but definite improvement but at no time during this period was operative interference considered justifiable. On November 1, phrenic anastomosis was performed and on November 20, extrapleural collapse was begun. A total thoracoplasty in four stages was carried out between November 30, 1930 and January 6, 1931. The serious condition of this patient necessitated long intervals between stages and it is interesting to note that quite definite improvement followed each stage. The contralateral lung remained healthy. The patient continued to improve and was discharged August

1931 with a small amount of 20 cubic centimeters capacity in the region of the drainage wound and without cough or sputum. This man was well and doing light work from the time of discharge 1, November 31, 1931, when he died following an operation for acute intestinal obstruction in his home hospital. (He had had a fecal fistula which necessitated operative closure following an operation for acute appendicitis in June, 1930, 9 months prior to developing tuberculosis.)

An unroofing operation should not be performed if the cavity is large. Watson reserves this operation for cavities of 150 cubic centimeters or less. Considerable shock accompanies an extensive unroofing operation and the subsequent chest wall protection is poor. This mistake was made in some of our earlier cases.

The severe mixed infection type of tuberculous empyema always presents a grave prognosis. Provided the patient's condition warrants operative interference, there should be no delay in instituting surgical measures. Archibald reports 15 cases of this type, in which 8 could be treated only by a small rib resection and drainage. These went on to death from progressive tuberculosis, at various intervals, independently of the operation. The 7 remaining were treated by total

thoracoplasty: 2 patients dying in hospital, the 5 remaining were discharged as clinically cured.

RESULTS

This paper is based on a study of 15 cases definitely proved tuberculous, referred for surgical treatment by the medical staff of the Saskatchewan Anti-Tuberculosis League during the years 1926 to 1932 inclusive. All cases in this group were of the mixed infection type. There was 1 death, a mortality by case of 6.6 per cent. A total of 44 operations were performed, the mortality by operation being 2.2 per cent.

The oldest patient was 58 and the youngest 4, the average age being 31 years. There were 13 males and 2 females. The right side was involved 8 times and the left 7. Six cases were complicated by bronchial fistula and 6 were admitted with previous rib resection; 2 had empyema necessitatis. Three showed contralateral lung disease. Amyloid disease was present to a marked degree in one case and moderately so in one other. The average length of time of the duration of the empyema prior to operation was in 14 cases 3 years and 3 months. The remaining case was a man of 58, who on admission had an empyema evidently of long standing. The history pointed to a bronchial fistula which closed from time to time.

This man was a farmer, lived in the open and for years had never consulted a doctor. The only suggestive history of tuberculosis was that 13 years previously at the age of 25 he was confined to bed with what he termed "a cold" for a period of 3 months, with cough and expectoration. Just how long his empyema had existed could not be determined. The patient died, the result of pneumonia in



Fig. 14



Fig. 15

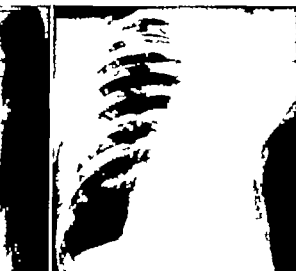


Fig. 16

Fig. 14. Case 4. A B Two months after thoracoplasty to drain residual cavity following thoracoplastics. Lipiodol injection

Fig. 15. Case 4. A B Three months after unroofing

operation. Roentgenogram shows cavity still present.

Fig. 16. Case 4. A B Complete obliteration following débridement and muscle graft to fill cavity is shown in this roentgenogram

the contralateral lung, 17 days after a first stage thoracoplasty. Autopsy showed chronic bilateral pulmonary tuberculosis. This was one of our earlier cases and with present experience would not now be accepted for operation.

years, 1 over 2 years and 3 between 1 and 2 years, and the remaining case less than 1 year. Two had small sinuses at time of discharge, one of these has since closed. In all others the cavity was

Three of the 15 cases were classed as mildly or moderately secondarily infected, having small loculated empyemata. One was a boy, aged 4 years, with a bronchial fistula and in which guinea pig inoculation was positive. His cavity was obliterated following drainage. This instance is unusual on account of the youth of the patient. The 11 remaining cases were classed as of the severe mixed infection type. In 6 an undocking operation was performed, in 1 case in one stage and in the remaining 5 in two stages. In these latter the cavities were large and in the light of subsequent experience extrapleural thoracoplasty would have been a better procedure. Of the 5 remaining cases, 1 was treated by posterior thoracoplasty with undocking of a residual cavity. In the 4 other cases, a total thoracoplasty was performed. Phrenic avulsion preceded thoracoplasty in 4 of the 11 cases. The cause of the mixed infection was rib resection in 6 cases, bronchial fistula in 6 cases, empyema necessitatis 2 cases, undetermined 1 case.

Of the 14 cases discharged from hospital, 13 are now living, 1 dying 4 months after discharge, the result of an operation for acute intestinal obstruction. This death cannot be attributed to the chest condition. Three patients have been discharged over 6 years, 2 over 5 years, 3 over 3



Fig. 17. Case 4. A B Posterior view showing full range of movement at shoulder

TABLE I—CAUSES OF SECONDARY INFECTION

	Cases
Rib resection	6
Empyema necessitatis	2
Bronchial fistula	6
Undetermined	1
Total	15

obliterated and in no case has there been a recurrence of cavity formation.

The present condition of these patients has been classified as "unimproved," "improved," or "well and working." By "well and working" is meant that a patient is able to do a certain amount of work daily. One patient is unimproved and is now in hospital elsewhere with progressive bilateral pulmonary disease. One patient is improved and one other is too recent to classify. The remaining cases are "well and working." One patient reports he is able to do a full day's work on the farm. The majority of the remainder are capable of doing 4 to 6 hours of work daily. One patient was married at the time of her discharge and is now doing her own housework. This patient showed marked amyloid disease but since discharge has put on 30 pounds in weight. The majority report a certain amount of dyspnea on exertion; they tire easily but consider themselves in good health. They have been followed closely since discharge and in most instances a yearly examination has been made by a member of the medical staff of the Saskatchewan Anti Tuberculosis League.

SUMMARY

1. Adequate study of all patients with empyema should be made before any surgical procedure is performed.

2. Sterile purulent effusions should not be drained externally.

3. Secondarily infected tuberculous empyemata usually require thoracoplasty.

The following additional case histories are illustrative of the type of empyema treated.

CASE 1. M. U. aged 21 years, a nurse in training, was admitted to Fort Qu'Appelle Sanatorium, December 6, 1926. Family and past history irrelevant. Patient was in good health until November 24, 1926. She was in bed 10 days with right pleural onset, with temperature. The diagnosis was questionable tuberculosis, December 2, 1926. On admission to the sanatorium she had no cough, no expectoration. X-ray films suggested spontaneous pneumothorax, right side, with effusion (fluid to level of second rib, anteriorly). In January 1927 750 cubic centimeters of pus was aspirated; the cavity was irrigated with emulsi. Aspiration was repeated at approximately weekly intervals and cavity was irrigated. March, 1927 pus from chest was positive for tubercle bacilli, by guinea-pig inoculation. July 1927 sputum, 3/6 ounce. Aspiration of

TABLE II

	Cases
Died after operation	1
Died since discharge	
Too soon to classify	
Unimproved	
Improved	1
Well and working	10

cavity at weekly intervals was continued, followed by irrigation and air replacement. February 1928, she began to run septic type of temperature. May 1928, sputum, 3 ounces. June, 1928 empyema necessitatis with spontaneous discharge of 6 ounces pus from chest anteriorly was diagnosed. From June, 1928, to May 1929, she had two persistent abscesses in third space anteriorly. When referred for surgical treatment in May 1929, she showed greatly enlarged liver and spleen. She had septic type of temperature. Her weight was 105 pounds. The contralateral lung was clear. June 24, 1929, a rib resection posteriorly was done for dependent drainage of empyema cavity following which abscess in anterior chest partially closed. Pus in chest again was positive for tubercle bacilli by guinea-pig inoculation. Following rib resection, the cavity was irrigated daily. The temperature abated but there was no reduction in size of cavity. September 19, 1929, a posterior thoracoplasty lower ribs, was done. October 9, 1929, a posterior thoracoplasty upper ribs, was done. Following total posterior thoracoplasty, a long, narrow cavity persisted, hourglass in shape with sinuses anteriorly over breast and posteriorly at site of rib resection. April 25, 1930, unroofing of cavity anteriorly was done. June 17, 1930, unroofing of cavity posteriorly was done. This was followed by obliteration of cavity and patient was discharged July 24, 1930. June, 1931 her weight was 130 pounds. She had no enlargement of liver or spleen. She was well nourished and appeared in best of health. She has married and does 6 to 8 hours housework daily. September 1933, her weight was 135 pounds. She continues to be in good health, with no cough, no dyspnea, is able to play golf and tennis, and swims without difficulty.

CASE 2. J. F. aged 42 years married, laborer-cook normal weight, 40 pounds, was admitted to Saskatoon Sanatorium, September 26, 1929. In February 1929, he injured the right chest falling a distance of 20 feet. There was considerable contusion of right chest but no open wound. He ran temperature of 101 degrees. He had a cough with some sputum and considerable dyspnea. He was in bed 1 week in hospital. The chest was strapped and he returned to work but collapsed the first day at work and returned to the hospital where he remained until April 1, 1929, with weakness, cough, and sputum. His weight was 100 pounds. At this time he had an X-ray of chest and on April 18, 1929, the chest was aspirated and thin pus was obtained. No culture was made. No guinea-pig inoculation was made. Aspiration was repeated on April 25 and in May 1929, rib resection was done. From May until admission to Saskatoon Sanatorium on September 26, 1929, he had a persistently discharging sinus and the cavity was treated by irrigation. On admission, sputum was 6 ounces, and was positive for tubercle bacilli. There was a free discharge from the sinus. The contralateral lung was good. He was put to bed and given general treatment. The condition improved and the sinus in the chest wall closed. On June 30, 1930, aspiration of the chest showed clear fluid. Five hundred cubic centimeters was aspirated and 10 cubic centimeters of 5 per cent gonococcal was injected. On July 3, 1930, 60 cubic centimeters of gonococcal was injected. On July 1, 1930, 50 cubic centimeters of gonococcal

was injected. From July to November 1930, there was no change in condition. The cavity occupied the whole of the right chest (Fig 8). Surgical collapse was decided on. Between November 4, 1930 and January 29, 1931 a complete costectomy in four stages preceded by phrenic avulsion, was performed. The cavity was not drained prior to collapse but as the fluid was clear the cavity was emptied by aspiration before and subsequent to each stage. Complete obliteration of the cavity was obtained and patient was discharged June 15 1931 4½ months following last operation. The weight on discharge was 131 pounds. He had no cough, the sputum was practically nil and negative for tubercle bacilli.

Follow up, February, 1933 daily sputum, 1 ounce negative for tubercle bacilli. The general health was good but he was dyspnoeic on continued exertion. He could do light work and had a slight morning cough.

CASE 4. A. B. aged 31 years, laborer was admitted to Fort Qu'Appelle Sanatorium, February, 1926. The previous history revealed influenza in 1918 when he was in bed 6 weeks. Subsequently he was indifferently well tired easily. In 1923 he had pain in both chests and developed cough and expectoration. In 1925 cough and sputum became worse. He was tired and weak all the time and began to lose weight. At the end of 1925 he developed fever with aggravation of symptoms. On admission, sputum was 4 to 10 ounces, positive for tubercle bacilli. It was classified III B. The right side showed parenchymatous tuberculous throughout, with cavitation. The left side showed an apical lesion. In November, 1926, patient developed spontaneous pneumothorax with fluid filling the whole right side. He was treated by aspiration and air replacement. By July 1927 the fluid was too thick to be aspirated. Early in 1928 he developed a bronchial fistula and irrigations were stopped. The bronchial fistula drained freely and he would cough up 16 ounces daily. From this time until 1931 he was treated with bed rest. The lesion on the left side began to clear and by July 1931 he was considered fit for surgical collapse. The sputum was positive for tubercle bacilli. From July 14 to October 24, 1931 a complete costectomy in four stages, preceded by phrenic avulsion was performed. The cavity was not drained prior to thoracoplasty. It was

considered that the large freely draining fistula would keep the cavity evacuated. This was a mistake, as after complete thoracoplasty there was a considerable cavity remaining, with sputum 6 to 8 ounces. December 18, 1931 the residual cavity was drained. Following this, the bronchial fistula closed, but the cavity did not decrease in size. March 18 1932 the cavity was unroofed and soft tissues allowed to fall in, but no healing took place. June 28, 1932 the roof of the cavity was completely excised and the cavity left open, and packed with bipp gauze. After several months of treatment with ultraviolet light on open cavity there was no attempt at filling in by granulations and on January 18 1933 two large muscle transplants from the pectoralis major in front and latissimus dorsi behind, were placed in the cavity after débridement of the cavity bed. The muscle transplants were stitched to edges and the skin closed tightly without drainage. Primary healing resulted. Patient was discharged 2 months after last operation. The sputum was reduced to 2 ounces and was negative for tubercle bacilli.

The author wishes to acknowledge his indebtedness to Dr R. G. Ferguson, director of medical services, Saskatchewan Anti Tuberculous League, by whom this material was made available and to Drs H. C. Boughton and W. S. Barclay of the Saskatoon Sanatorium for valuable assistance and co-operation in the treatment of these cases.

REFERENCES

1. ALEXANDER, JOHN. Surgery of Pulmonary Tuberculosis. Philadelphia Lea & Febiger 1925
2. ARCHIBALD, E. A. The surgical treatment of tuberculous empyema. Canadian M. Ass. J. 1930 23 160
3. HAMILTON, G. H. Superintendent, Fort Qu'Appelle Sanatorium. Personal communication.
4. HEDBLOM, C. A. The diagnosis and treatment of tuberculous empyema. Surg. Gynec. & Obst. 1922 24 445-465
5. Idem. The surgical treatment of tuberculous empyema. J. Thoracic Surg. 1932 11 December
6. KELLER, W. L. Treatment of tuberculous empyema. Ohio M. J. 1930, 26 21-26

UTEROSALPINGOGRAPHY BY INTERRUPTED FRACTIONAL INJECTIONS

A MODIFIED AND IMPROVED TECHNIQUE¹

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DIAGNOSIS in gynecology is based largely on the fundamental methods of examination, in association with microscopic and histopathological studies. In some instances, however the usual procedures alone are inadequate to establish a positive diagnosis, and neither the lesion nor its exact location can be definitely recognized. With the development of improved apparatus, radiopaque media and a standardized technique roentgenography has become a valuable diagnostic aid by visualizing previously obscure pathological conditions. The technique of uterosalpingography is simple and does not necessitate hospitalization of the patient, except under unusual circumstances. However its application must be limited to properly selected cases.

Uterosalphngography was originally adapted for visualization of the lumen of the fallopian tubes in cases of sterility. With continued use its diagnostic and prognostic value has increased to an extent undreamed of by its original advocates.

The accepted procedure is to distend the uterine cavity with one or two injections totalling 8 to 10 cubic centimeters of a radiopaque contrast solution and make X ray exposures. Another film is taken after an interval of 24 hours. During the course of injection abdominal cramps are not infrequently complained of in some instances so severe as to necessitate discontinuing the injection when only partly completed. The dense shadow cast by the solid column of opaque fluid in the uterine cavity often obscures the presence of small intrusions and irregularities in the contour of the lumen of the uterus and fallopian tubes and filling defects of diagnostic import may not be delineated. The forceful injection of a relatively large amount of contrast solution may result in its entrance into the vascular system. The uterus has no submucosa on account of the intimate relationship of the mucosa to the underlying plexus of vessels, any break in the continuity of the mucous membrane may be accompanied by injury or laceration of the contiguous vessel wall through which the forcibly injected solution may pass into the circulation.

To overcome some of the objections and to eliminate possible sources of error the method

which is herewith described and which is based on the following principles, has been developed.

1 Successive injections of 2 cubic centimeters each of the contrast solution are made.

2 The field is exposed to the roentgen ray after each injection and the films are developed immediately.

3 The wet films are inspected to check the technique, so that modifications may be made as are deemed necessary to give maximum diagnostic data.

PREPARATION OF THE PATIENT

To evacuate the lower bowel a mild laxative is given on the night before examination and a soap suds enema the next morning. The bladder is emptied by voiding or catheterization. The patient is placed on an X ray table equipped with a Bucky diaphragm she is placed in the lithotomy position which is maintained throughout the examination. The vulva and vagina are scrubbed with tincture of green soap and water followed by a pitcher douche of oxycyanide of mercury 1:2000 at a temperature of 110 degrees F.

TECHNIQUE

A bivalve speculum fitted with the Hyams diagnostic light carrier is placed in the vagina and the cervix and cervical canal swabbed with a 3½ per cent solution of tincture of iodine. Depending on the position of the uterus and the direction in which the portio points, a tenaculum is placed on the anterior or posterior lip of the cervix. A sterile uterine sound is introduced into the uterine cavity to determine the length and position of the canal. A flexible tipped cannula attached to a Luer syringe is inserted into the uterine canal until the shoulder of the rubber acorn fits snugly into the external os.

With traction on the tenaculum and pressure on the cannula, a small amount of air is introduced into the uterine cavity to ascertain whether or not there is leakage around the acorn. If the cervix is extensively lacerated, precluding a complete closure with the cannula, the anterior and posterior lips may be approximated on each side with a tenaculum to reduce the size of the opening to permit complete occlusion with the cannula and

¹From the service of Dr. Walter T. Dunsenrother, Department of Gynecology, New York Post Graduate Medical School and Hospital, Columbia University.



Fig. 1. Uterosalpingography by fractional method. First exposure of a series taken October 24, 1932, before treatment, after injection of 2 cubic centimeters of radiopaque medium. Uterus partially filled.

to prevent leakage into the vagina. If there is no leakage the instrument is removed and a syringe filled with 10 cubic centimeters of warmed lipodol is attached to the cannula, and enough solution is forced through to expel the air from the instrument. As soon as the oil appears at the tip the cannula is reinserted into the uterine cavity and the fractional injections are made.



Fig. 2. Second exposure same case as Figure 1, after injection of additional 2 cubic centimeters. Uterus incompletely filled, fluid has not yet entered fallopian tubes.

The contrast medium is introduced by gradual but steady pressure in five separate injections of 2 cubic centimeters each with an interval between each injection for X ray exposure and immediate development of films. During this brief period between successive exposures the wet films are inspected for control of errors in technique or to

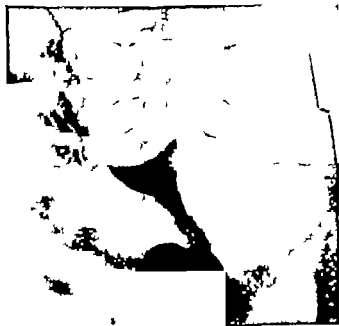


Fig. 3. Third exposure same case, after third injection of 2 cubic centimeters of fluid. uterus filling, fluid is seen entering the tubes.



Fig. 4. Fourth exposure same case, after fourth injection of 2 cubic centimeters of fluid. uterus and tubes delineated, filling defect of uterus.



Fig. 5 Fifth exposure same case, after a total of 10 cubic centimeters has been injected into uterine cavity. Note filling defect of uterus tubes well delineated. Diagnosis submucous fibroid.



Fig. 6 Twenty-four hour exposure of same case. Demonstration of fluid throughout pelvis.

elaborate on the procedure if necessary. To preclude leakage the instrument must be held in position during the course of the examination. The entire procedure rarely requires a half hour. The patient is requested to return after 24 hours for a final X-ray exposure. This exposure is

made with the patient in the dorsal posture without preliminary preparation and completes the series of six exposures.

Most of the instruments used for insufflation and salpingography have been constructed of rigid metal, slightly curved at the distal end, and varying in size from No. 12 to 20 French. Anatomically, the cervical canal is not uniform in



Fig. 7 Same case as Figure 1. Diagnosis of submucous fibroid confirmed by diagnostic curettage on October 30, 1932. This film was taken 2 months after intra-uterine application of radium, 600 millicurie hours. Irregularity of uterine cavity diminished.



Fig. 8 Same case as in Figure 1. This film was taken 1 year after the application of radium. Uterine cavity appears normal. Patient symptomless.



Fig 9. Congenital anomaly elongation of fallopian tubes.



Fig 10. Bicornuate uterus

size, shape or course, nor is the uterus always in its normal position. In passing a large rigid cannula through the cervical canal into the uterine cavity, considerable trauma may result because of the disproportion between the size of the sound and the diameter of the cervical canal the lumen of which may be distorted by congenital abnormalities or by trauma. The same principles apply also to the internal os and corpus uteri. To overcome these difficulties I have devised a flexible tip¹ for the cannula to take the place of the rigid end.

The advantage of this method of interrupted fractional injections is the complete absence of cramp-like pains or unpleasant sensations in the lower pelvis so frequently associated with the injection of the large amount of fluid into the uterine cavity at one time. The patient is comfortable and completely relaxed, she is able to remain motionless and to co-operate, all of which helps to facilitate the making of good X-ray exposures. This method of injection permits following the progress of the solution as it fills the uterus and fallopian tubes, filling defects and pathological changes are more accurately visualized and located. In view of the fact that the injections are

controlled by specific quantities of the medium, physiological distention of the uterus and fallopian tubes is less dangerous and is accompanied or followed by a minimum of reaction. The technique precludes the possibility of untoward results and gives a maximum amount of information. The possibility of such disagreeable sequelae as vascular injection with the media is excluded.

Delineation of the uterine cavity by this method often differentiates an ovarian cyst from a fibroid, and will also disclose polyps or submucous fibroids protruding into the uterine cavity which might otherwise escape notice. Bicornuate uteri and other congenital uterine or tubal anomalies are clearly outlined in a uterosalpingogram.

While congenitally elongated fallopian tubes are uncommon they do occur and may be the cause of persistent sterility. A young woman presented herself for primary sterility. Repeated transuterine insufflation tests proved the tubes to be patent and a salpingogram confirmed these findings. However the tubes were found to be tremendously elongated reaching to within 1 inch of the crest of the ilium. Since the insufflation tests proved that the tubes were open it was logical to assume that pregnancy could occur but the salpingogram indicated that while possible this was extremely improbable (Fig 9).

¹The instrument embodying this improved flexible tip feature was described in detail in the *Am J Obst and Gynec*, May, 1953.

Although skiographic delineation of the uterus and fallopian tubes has been used in the diagnosis of early pregnancy and despite the fact that abortion has seldom followed, its use for this purpose cannot be recommended. The Aschheim-Zondek test and its modifications have proved more reliable than all others for this purpose. I must confess to having inadvertently made salpingograms during the first month of pregnancy in two cases, unaware of the presence of a gestation sac. In neither case was the pregnancy interrupted by the incidental manipulations both patients going to term and having normal deliveries.

A hydrosalpinx manifesting no gross enlargement on palpation can be demonstrated by salpingography, and an unsuspected hematosalpinx or pyosalpinx may be revealed in the same way. Salpingography is also of value in determining the presence or absence of tubes in patients who have had a previous operation on the adnexa but who are uncertain of its nature.

At all times, the degree of pressure used to inject the radiopaque medium into the uterine cavity and tubes must be moderate. Excessive distention may result in the rupture of a tube in the presence of an unsuspected tubal disease and for this reason is particularly dangerous in cases of tubal pregnancy.

Röntgenography of the pelvic viscera must be avoided during menstruation and the 5 days before the onset of a flow. The best time is about 7 days after the bleeding has stopped. A suspicion of either uterine or ectopic pregnancy is also a contra indication. It should not be attempted in the presence of active inflammation of the external genitalia, vagina, cervix or adnexa because it might be responsible for upward extension of an infection. Indiscriminate use of the X-ray and opaque medium in gynecological diagnosis must be avoided and the contra indications must be scrupulously observed.

SUMMARY AND CONCLUSIONS

1. A new method of fractional uterosalpingography is presented.
2. It has distinct diagnostic advantages over the accepted methods.
3. It is attended by little or no pain and is without danger in properly selected cases.
4. By its use, abnormalities or pathological changes, difficult or impossible of interpretation by other methods, can be frequently demonstrated.
5. The proper instruments as well as exact and careful technique are necessary to obtain the best films.
6. Hospitalization is not necessary except in unusual cases.

TUBERCULOUS ABSCESES OF THE BRAIN SECONDARY TO TUBERCULOSIS OF THE CÆCUM

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THE central nervous system is not infrequently invaded by tuberculosis. This invasion usually occurs as tuberculous meningitis miliary tuberculosis or less frequently as single or multiple tuberculomata. Tubercle or tuberculoma formations may become confluent and involve relatively large areas of the brain, caseation and breaking down of tissue with secondary infection resulting. On the other hand, true tuberculous abscesses of the brain are very rare. Their pathology differs from that of tuberculous abscesses elsewhere in the body in that it does not involve the various stages of granulomatous change to be expected from an infecting organism of this nature. Apparently these abscesses are blood-borne infections from a chronic tuberculous process elsewhere in the body. The method of abscess formation resembles that of other cerebral abscesses caused by pyogenic infecting organisms when these are blood-borne. There is probably a primary period of localized encephalitis, a secondary period of softening, and a final period of capsule formation in the development of a true abscess. The case here reported is of such a type.

CASE REPORT

Tuberculous abscess of the cerebellum and right frontal lobe complicating a tuberculoma of the cecum in a Japanese 46 years old.

M. Y. Japanese male, fish merchant, aged 46 years and single, referred by Dr. K. Tashiro of Los Angeles, on October 23, 1933 for symptoms resembling those of a tumor of the brain. He was born in Japan coming to this country at the age of 18. He is said to have had an attack of acute appendicitis in 1925 for which he was not operated upon. He was a heavy smoker and drinker. There was no history of chronic cough, chills, fever, expectoration, or loss of weight. On May 12, 1932 he was examined by Dr. Walter Wessels of Los Angeles, who obtained a history that during the previous 3½ months he had developed slight pain in the abdomen morning and evening. A month prior to Dr. Wessels' examination he had had an attack of colic which lasted 1 day; this was followed by constipation which was relieved by taking some gas powders. There had never been any nausea or vomiting.

His physical examination was entirely negative except for 3 devitalized teeth, a slightly enlarged heart and a tumor mass in the right lower quadrant. This mass was described as being about the size of a lemon, rather hard, freely movable, smooth, occupying a position 3 centimeters to the right of the umbilicus and extending from the level of the umbilicus downward for 5 centimeters. The right kidney could be felt above and was distinct from the mass. A gastro-intestinal study was negative except that

the ascending transverse and descending colon was found to be narrow and spastic. The ascending colon was interfered with by the palpable mass which moved with it upon manipulation. The cecum was tilted. The bowel appeared to be pushed to the extreme right. No appendix was seen. The blood Wassermann was negative. Urinalysis and examination of the stool were negative. Blood count: hemoglobin 80 per cent, red blood cells 4,480,000, white blood cells 14,000, differential lymphocytes 26 per cent, polymorphonuclears 57 per cent, large lymphocytes 9 per cent, mononuclears 5 per cent, eosinophils 3 per cent. The diagnosis at that time seemed to rest between (a) perityphilitis, (b) Meckel's diverticulum, (c) omental cyst, (d) hydatid cyst, and (e) carcinoma of the cecum. An exploratory laparotomy was recommended but was not carried out.

When first seen by me on October 22, 1933, a different picture presented. There was a large movable tumor in the right lower quadrant of the abdomen which was not painful or tender on pressure but which was now about the size of a man's fist. The patient gave a history also of periodical attacks of partial intestinal obstruction. Roentgenological studies following a barium meal test showed a marked filling defect in the region of the cecum.

There was a further history of headaches dating back about 4 weeks. The pain was most marked in the right suboccipital region. There had been a great deal of nausea and frequent vomiting. The patient had lost weight. He had been unsteady on his feet and apparently very ataxic. He preferred to lie on the right side, becoming very dizzy if he turned to the left side. One made out no evidence of tuberculous in the chest. The sense of smell was present on the right side but lost on the left side. His discs showed no choking. There was a slight horizontal nystagmus on looking to the right, none on looking to the left. There was slight weakness of the right lower face. The Romberg symptom and gait could not be tested but when propped up in bed the patient fell backward and to the right. There were no abnormal reflexes of the Babinski group on either side. No ankle clonus was present. Blood Wassermann was again negative. A spinal fluid examination showed a clear fluid, containing one cell, marked increase in globulin, negative Wassermann. Colloidal gold curve oooooooooo. No tubercle bacilli or other organisms were seen.

The presence of an expanding lesion in the right cerebellar lobe was suspected. The question arose as to whether this was secondary to the tumor in the abdomen and an exploratory laparotomy was suggested.

On October 28, 1933 the patient was operated upon by Dr. K. Tashiro. At operation the mass proved to be an extensive tubercular lesion involving a very movable cecum and the adjacent terminal ileum, with regional mesenteric and omental changes. The cecum and lower portion of the ascending colon were quite thickened and moderately indurated as was also a portion of the terminal ileum about 3 inches long. The appendix was retrocecal and bound down in a mass of adhesions. An extensive resection of the cecum and ascending colon as high as the hepatic flexure and also including 6 inches of the terminal ileum was carried out. An isoperistaltic side-to-side bowel anastomosis was then done, uniting the transverse colon to the terminal ileum. The wound was drained with a cigarette

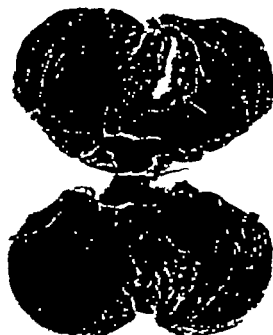


Fig. 1. Cerebellum cut in horizontal plane to show tuberculous abscess in cerebellar lobe adjacent to vermis.



Fig. 2. Coronal section of brain showing tuberculous abscess in right frontal lobe. Note the discrete capsule and absence of gross inflammatory changes about the abscess.

drain and then closed. Following this, so far as abdominal symptoms were concerned, the patient made an uneventful convalescence. The wound healed *per primam* and free bowel motion was re-established.

About a week after this the patient suddenly began to develop signs of meningeal irritation, stiffness of the neck, a positive bilateral Kernig sign and drowsiness. His temperature suddenly arose to 101 degrees. His coma deepened and he died on November 6, 1933. An autopsy of the brain was permitted. Gross and microscopical study of this organ and of the resected cecum were reported by Dr. C. B. Courville of Los Angeles in part as follows:

Gross pathology. The specimen consists of the dura mater covering the dorsolateral surfaces of the cerebral hemispheres, the entire brain and the cecum, the latter being a surgical specimen.

Brain. The convolutions of the brain over the right hemisphere seemed to be somewhat universally flattened as compared to those of the opposite side. There were no particular areas, however, in which any unusual flattening was observed to point out the location of an underlying lesion. There has been in the recent state a fairly marked cortical congestion, and many of the smaller radicals are still visible even after embalming. The arteries are rather thin-walled throughout, although their tortuosity, especially over the cerebral cortex, would suggest that the patient was past middle age. The arachnoid shows considerable minor thickening and opacity in the region of the Sylvian fissure, but not to the extent indicative of an inflammatory process.

One rather interesting incidental finding is the extremely small size of the olfactory tracts, which are found as thin, string-like structures in the olfactory sulcus. There is a minor grooving of the uncusate region on either side

and extends back particularly on the left to include a part of the hippocampal gyrus.

There is a bilateral herniation of the cerebellar tonsils about the medulla in the region of the foramen magnum. There is also a marked herniation of the anterior two-thirds of the superior vermis and an adjacent triangular portion of the superior surface of the left cerebellar hemisphere through the tentorium. This herniation is undoubtedly due to the occurrence of a cerebellar lesion to be described later, and has taken place caudal to the brain stem.

On the midpoint of the upper surface of the right cerebellar hemisphere adjacent to the vermis there is what appears to be a fluctuant area in this region, indicating its presence by loss of cortical markings, which measures 1.7 by 3 centimeters in its present state. The folia about this area are likewise considerably flattened and distorted.

The cerebellum was cut in a horizontal section, passing through its anterior and posterior margins. This section reveals a fairly large encapsulated abscess in the upper part of the medial position of the right cerebellar hemisphere, extending into the adjacent vermis (Fig. 1). There is apparently the capsule of this abscess observed on the superior surface of the lobe. The abscess in its collapsed state measures 2.1 by 2.7 by 3.2 centimeters in its greatest transverse diameters. There is no evidence of loculation and diverticula from the main abscess cavity. The cavity is lined with a slightly uneven but well defined layer of greenish colored granular pus.

There is next found a somewhat indistinct connective tissue capsule which varies between one-half and one millimeter in thickness. Outside of this a third layer is found consisting of a narrow, very well defined zone of reaction which is bright red in color and is evidently accompanied by considerable local congestion. The adjacent brain tissue seems to be remarkably well preserved. There is no evidence of rupture of this abscess. There is, however, considerable distortion and flattening of the fourth ventricle, which is reduced to a mere transverse slit. The dentate

nucleus on the right is likewise compressed and distorted. There may be a slight edema of the white substance of the right cerebellar lobe as compared with the left. The abscess seems to have occurred predominantly in the narrow strip of white matter which radiates around the vermis toward the medial end of the posterior border of the lobe and has not disturbed the main centrum to any appreciable extent.

"The cerebral hemispheres were sectioned in a coronal fashion beginning at the frontal lobes. The section which passes through the tips of the temporal lobes and just anterior to the genu of the corpus callosum reveals a slightly irregular contoured oval shaped cavity in the lower outer centrum of the right frontal lobe adjacent to the sylvian fissure. It is separated by a narrow zone of white substance 1.5 millimeters in thickness and by a very much attenuated and thinned cortex from the surface of the brain. The abscess cavity measures 2.2 by 2.5 by about 3 centimeters (anteroposterior diameter) in its greatest cross-sectional diameters (Fig. 2). The central portion of the cavity was filled with liquid, greenish yellow pus, while adjacent to the capsule there was a zone of more solid pus still of greenish color but probably containing more fibrin. This pyogenic membrane can be separated from the capsule with a little difficulty showing that organization of this portion had not occurred. The active connective tissue capsule must be very thin, for it was difficult to make out grossly, and probably in no place was it more than one-half a millimeter and often much less in thickness. Surrounding the capsule proper there is a brilliant reddish zone, evidently a zone of reaction in the surrounding tissues. This, however, is sharply circumscribed and within a millimeter or two outside this zone there is remarkably little evidence of any disturbance whatever. The white substance of this side shows only slight evidence of edema, as suggested by a slight distortion of the midline structures.

"Further sections of the brain further indicate an edema of the right frontoparietal centrum. Both lateral ventricles are dilated, probably due to the occlusion of the fourth ventricle. There is a slight distortion of the ventricular pattern with a minor deflection toward the left. This seems to be even more marked in succeeding sections where the third ventricle is found to be likewise markedly distorted and also deflected toward the left. The posterior horns are markedly dilated, and in this region the ependymal lining shows a number of small discrete petechial hemorrhages. There seems to be no evidence of active inflammation in the ventricle.

Smears from both abscess activities reveal numbers of tubercle bacilli.

Cecum. The colon specimen shows a large irregular yellowish gray mass in the region of the cecum, which has invaded the bowel and caused an irregular ulceration. In this region the wall on cut section is found to be thickened, is very firm, and presents in some areas a whitish fibrous appearance, and in others a cartilaginous structure. In the outer portions of the mass there is more of a characteristic fibrous or fibrocaceous structure. As near as can be determined from the relationship of the appendix it seems as though the entire lower portion of the appendix has been involved up to the base of the appendix. The wall of the appendix likewise seems to be thickened, firm and opaque in the upper two-thirds of its extent, and on cut section the tissue has a sort of gelatinous texture so this organ has evidently partaken of the inflammatory process. The ulceration within the cecum is very irregular and there is apparently a loss of epithelium down to the firm tumor tissue (Fig. 3).



Fig. 3. Resected tuberculous mass including portions of colon, cecum and appendix, A. The tuberculous mass is indicated by arrows.

"Histopathology. The following sections were taken from the abscess in the right frontal lobe.

"Section 1. Hematoxylin and eosin (Fig. 4). The abscess wall was characterized by an irregular friable layer of wandering cells whose structure was not clearly made out, evidently having undergone a marked degree of degenerative change. There was next a thin wall of connective tissue also infiltrated with wandering cells. Just external to this wall the brain tissue was found to be edematous and there was a certain increase in number of the interstitial cells. The overlying cortex had undergone a minor degree of edematous change and was somewhat friable, but had undergone no gross arachnoidal change. The cells forming the crustate were examined under higher magnifications, but because of degenerative change their morphology was difficult to make out, however many of them were obviously polymorphonuclear cells. There were also many mononuclear cells and some plasma cells observed. These cells could also be found in the connective tissue walls altho the mononuclear and plasma cells predominated.

"Schick R for fat. There was only a minimal amount of fat in the pyogenic layer, but outside of the wall were found numerous fat laden phagocytes, more abundant in some sections than others, and inclined to be scattered thru the tissue.

"Section 2. Stain for tubercle organisms. Ziehl-Neelsen (Fig. 5). Examination of the section under oil immersion reveals a large number of beaded or granular organisms both in the crustate and in the inner portions of the capsule of the abscess. These disappeared as the outer portion of the capsule was approached, so that none was found in the adjacent brain tissue.

"Gram-Weigert stain. This method was used to determine whether or not other organisms might be present. It showed a number of beaded or granular bacilli which seemed to be enclosed in capsules. These organisms were Gram positive and were probably tubercle bacilli. Smaller forms which were rounded, resembling diplococci were also observed, which were probably small forms of the same organisms.



Fig. 4. Section of wall of frontal lobe abscess showing inflammatory reaction and connective tissue formation of capsule. No tubercles are present. Hematoxylin and eosin method. $\times 80$.

Reticulum dasi. This section shows a rather condensed capsule of rather uniform size. There is slight tendency to a fibrosis of the pyogenic layer, the processes extending from the walls of local blood vessels, which at times seem to be increased in number. There is also an evident increase in number of blood vessels in some portions of the brain, from which a beginning fibrosis is taking place.



Fig. 5. Section of abscess wall right frontal lobe showing numerous tubercle bacilli scattered through the capsule. Ziehl-Nielsen method. $\times 900$.

Section 3. Gold sublimate method. This method reveals some tendency to a proliferation of the astrocytes, but rather peculiarly at a distance from the wall of the abscess proper. These cells are predominant in a layer just beneath the cortex, while the intervening brain tissue between this zone of gliosis and the abscess wall is occupied by a cell which has undergone a degree of regressive change. This differs somewhat from the usual abscess in which an active proliferation of these cells is to be found immediately outside of the connective tissue wall.

"Cajal's reduced silver method." This method reveals nothing further of importance.

"Section from margin of tuberculous mass of caecum."

Hematoxylin and eosin (Fig. 6). The section is taken from the margin of the mass in the caecum so that normal tissue could be found to compare with the abnormal. This is also taken with the purpose in mind of observing transitional stages of the process. Even in what appears to be normal tissue grossly at the margin of the mass are observed small tubercles of characteristic structure and containing typical giant cells. These tubercles are found predominantly in the submucosa but at times are also observed in the muscular coats as well, particularly in the superficial portions. In the muscle layer and in the subserous tissues are found collections of lymphocytes with small hemorrhages about the blood vessels. As one approaches the involved area there is a gradual replacement of the normal tissues with tuberculous tissue. The muscle coat is broken up and replaced with fibrous tissue, a reticular tissue, or with typical tubercles, which may be conglomerate. The subserous and epithelial layers are quite abruptly replaced with tuberculous tissue which at first diffusely invades the normal lymphoid tissue or replaces it with discrete tubercles. The lymphoid tissue becomes less and less conspicuous until finally there remains only small lymphocytic infiltration accompanying the pathological process. The glands seem to terminate quite abruptly for a short space, however, their remains can be identified by



Fig. 6. Numerous conglomerate tubercles shown in submucous coat of caecum. This process is quite different from that shown in the brain abscess of the frontal lobe. Hematoxylin and eosin method. $\times 36$.

elongated spaces filled with red blood cells. In the margin of this tuberculous mass only an occasional gland can be made out. The characteristics of the abnormal tissue are typical fibroblasts, lymphocytes, plasma cells and giant cells forming typical tubercles or a more diffuse new formed tissue.

"*Diagnosis* Tuberculous abscess of the right frontal lobe."

It is difficult to find, in the literature, reports of proved tuberculous abscess of the brain.

MacEwen (1893) discusses the possibility of abscess of the brain as a complication of tubercular disease of the middle and inner ear. He mentions the fact that there may be extensive tubercular destruction of the osseous walls, a condition which I believe is rarely seen today. When abscess occurs in such cases it is usually superficial communicating with the middle ear often by minute passage through the granulation tissue. MacEwen states "Instead of a distinct abscess in the midst of the cerebral tissue, a superficial cerebral ulceration is occasionally found in connection with tubercle of the middle ear, the pus from this ulceration being confined by the soldering of the meninges at the periphery of the ulceration to the base of the brain and the dura respectively. Such a purulent collection might thus appear as a localized cerebral abscess the pus being retained between the brain which formed the dome and the dura which formed the floor of the abscess cavity. In his series of 25 brain abscesses there was no case of true tuberculous abscess located in the substance of the brain.

Oppenheim (1911) mentions the fact that "in rare cases the *tubercle bacillus* has been found in the internal wall of the granular tissue lining the abscess, and in the pus itself (A. Fraenkel)." He goes on to state that he himself has found the tubercle bacillus in such an abscess during operation.

Reik (1910) reports a case of cerebral tuberculosis following otitis media in a 3½ year old colored boy, which was probably not a true tuberculous abscess in the sense we have defined it. The case, the report of which is well illustrated, shows the left temporosphenoidal lobe to be almost entirely involved in the process. The disease had extended from the middle ear, solitary tubercles being found in the dura at autopsy and large areas of tuberculous caseation being present in the temporal and parietal lobes. This caseation caused considerable destruction of both the gray and white matter, but was not surrounded by a true abscess wall.

Schorstein in the Schorstein lecture of 1909 comments upon the rarity of tuberculous cerebral

abscess secondary to tuberculosis of the lungs. He cites Gowers (1888) as stating that cerebral abscess never occurs when true tuberculous cavities are present in the lungs. However this is not necessarily true, as Rudolph Meyer (1867) mentions one case of abscess of the brain with co-existing tuberculosis of the lungs. Again Finlay (1886) quotes a case of Dr Hadden's of tuberculous pyopneumothorax with abscesses in the frontal and occipital lobes of the brain. Likewise he mentions one case recorded by Huguénin (1878). Fraenkel's case is again mentioned, and one recorded by Wernicke and Hahn where an abscess in the left occipital lobe was drained by trephining. The patient survived for 13 days and at postmortem examination tubercles were found about the abscess cavity. Fraenkel was of the opinion that there was a definite connection between the cerebral abscess and tuberculosis of the lung. Schorstein comments upon the fact of the very great infrequency of tuberculous cerebral abscess in association with pulmonary tuberculosis, calling attention to the relative frequency of brain abscess in connection with bronchiectasis. "Cerebral signs in tuberculosis of the lungs point almost invariably to tubercular meningitis. Cerebral signs in bronchiectasis mean in nearly every instance cerebral abscess."

In discussing the etiology of brain abscesses in general, Gowers (6) again (1898) states "The last local cause (extremely rare) is a tubercular growth in the brain, which has been known to break down into a collection of pus. Other tubercular tumours and other evidence of tubercle are usually present, and indicate the origin of the abscess." The tuberculous process which he describes is the more common finding and is different from the pathology which we are discussing.

Hasson (1915) reports a case of multiple tuberculous brain abscess associated with dementia. The abscesses, however "had no capsules and were separated from the cortex by an area of seemingly normal white substance. The abscess cavities were filled with a pea green to yellow colored pus of a very offensive odor." Cultures and smears made from this pus were sterile. The diagnosis of tuberculous abscess being based upon the fact that the patient had "a chronic ulcerative and miliary tuberculosis of the lungs, combined with tuberculous osteomyelitis of sternum."

Adams (1896) under the title of "Tuberculous Abscess of the Brain" reports a case of a 10 year old colored boy who died of miliary tuberculosis. The right half of the brain contained many nodular masses which were probably miliary

tubercles or tuberculomata of various sizes. In the center of these masses was an abscess mass $2\frac{1}{2}$ by 2 by $1\frac{1}{2}$ inches which contained "yellowish turbid liquid within ragged cheesy walls. These were in the right frontal lobe. The pathologist reports that the tumors in the boy's brain showed only a few giant cells, the greater part of the mass being without any recognizable structure."

Leontine (1919) reports the case of a 27 year old man with a far advanced pulmonary tuberculosis. The sputum was positive, the lungs extensively involved, a tuberculous colitis was present, and a tuberculous meningitis suspected. At autopsy a tuberculous area in the parietal bone, which had caused extensive erosion, was found. The brain presented a large caseous area of tuberculosis which was apparently not a true abscess although it was so described in the title of the article.

Evans and Smith (1931) reported a case in a 14 year old girl who had an extensive scrofula of the neck of 8 years duration. This patient had daily convulsions of increasing severity for 3 weeks and a terminal hemiplegia. The spinal fluid examination 2 months before death showed a clear colorless fluid containing 9 cells—all of which were lymphocytes—trace of albumin and globulin, a negative Kahn reaction and a delayed positive reaction in testing for sugar by Benedict's method. Bacteriological examination and guinea pig examinations were negative for tubercle bacilli. Another spinal fluid examination 3 weeks before death showed increased pressure, 8 cells, positive albumin and globulin, bacteriological examination was negative. Before death the child developed choking of the lungs, mental torpor and incoherence in speech. Autopsy showed a large abscess in the left frontal lobe which contained thick greenish pus, the examination of which revealed abundant tubercle bacilli with typical morphology. There was no evidence of general meningitis. The pus was stained by Gram's method but no organisms other than tubercle bacilli were found. The region of the abscess was described as follows: "The outer layer of brain tissue showed practically no important changes with the exception of slight edema. Bordering upon the necrotic area, there was noted a circumferential proliferation of connective tissue cells. There was likewise noted a number of new capillaries lying among the fibroblasts. These young capillaries were congested. The central area was composed of necrotic tissue, leucocytes, and lymphocytes."

Among the cases mentioned apparently that of Evans and Smith is the only one of an undi-

puted tuberculous abscess. The gross illustration of their case is identical in appearance with ours. The process of formation is apparently the same as that of an ordinary pyogenic abscess. These authors found tubercle bacilli in large numbers in the pus, but did not try to identify them in the abscess wall. Such cases are not necessarily fatal for Naffziger, has cured one such case by drain age.

SUMMARY AND CONCLUSION

A case of multiple tuberculous abscesses of the brain is reported. This is believed to represent a rare type of tuberculous reaction in nerve tissue. The usual granulomatous or tubercle formation is not present. The abscesses apparently are formed as any other pyogenic abscess of blood-borne origin are. These tuberculous abscesses, when present, almost invariably accompany some other chronic tuberculous process in the body such as scrofula, tuberculosis of the caecum or tuberculous mastoiditis. In the case here presented typical tubercle formation was present in the caecum but was absent in the walls of the cerebral abscesses.

BIBLIOGRAPHY

1. ADAMS, S. S. Tubercular abscess of the brain. *Arch. Pediat.* 1866, 13: 607-609.
2. EVANS, G. F. and SMITH, C. F. Tuberculous abscess of the brain. *Am. Rev. Tuberc.* 1931, 21: 392-399.
3. FIXLAY, D. W. A case of empyema with cerebral abscess. *Lancet*, 1886, 308-309.
4. FRAENKEL, A. Ueber den tuberculösen Hirnabscess. *Deutsche med. Wchnschr.*, 1887, 13: 373-376.
5. GOWERS, W. R. A Manual of Diseases of the Nervous System. Diseases of Brain. Vol. 2: 443. London: J. & A. Churchill, 1883.
6. Idem. A Manual of Diseases of the Nervous System. Diseases of Brain, Vol. 2: 476-477. Philadelphia: P. Blakiston's Son & Co. 1898.
7. HARRIS, G. B. Dementia and multiple tuberculous brain abscesses. *Med. Rec.* 1915, 88: 737-740.
8. HROUDKOVIC, G. Acute und chronische Entzündungen des Gehirns und seiner Hülle, Ziemssen's Handb. d. spec. Path. u. Ther. 1878, 2. No. 1: 329-760.
9. JACOBOWITZ, G. E. Tuberculous abscess of the brain with subdural erosion involving the parietal bone. *U. S. Veterans Bureau Med. Bull.* 1929, 5: 371-373.
10. MACLEWEN, WILLIAM. Pyogenic Diseases of the Brain and Spinal Cord, p. 125. Glasgow: James MacLehose and Sons, 1893.
11. MERTZ, RUDOLPH. Zur Pathologie des Hirnabscesses. Dissertation, Zurich, 1867.
12. NAFFZIGER, H. C. In a personal communication Naffziger stated to the author that he drained a tuberculous abscess of the cerebellum which was secondary to a chronic mastoiditis. The granulation tissue which formed in the drainage tract so closely resembled a tuberculous reaction that he had some of it removed and injected into a guinea pig. Later the animal died of tuberculosis, indicating that he was dealing with a tuberculous lesion. After a stormy course of many months his patient recovered.

13. OFFENHEIM, H. Text book of Nervous Diseases vol. 2 5th ed p 890. Translated by Alexander Bruce Publisher T N Foulis, 1911
14. REIK, H. O. An unusual case of cerebral tuberculosis following tuberculous otitis media. Bull. Johns Hopkins Hosp., 1910, 21 223-235
15. SCHORSTEIN, G. I. Abscess of the brain in association with pulmonary disease. The Schorstein Lectures Lancet, 1909 177 843-852
16. WERNICKE, C., and HAHN, E. Idiopathischer Abscess des Occipitallappens durch Trepanation entleert Arch f path Anat., 1882 87 335-344

PARALDEHYDE AS A FACTOR IN PAINLESS LABOR

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IN a previous article (3) there was proposed a new procedure for inducing obstetrical analgesia and amnesia a method based on the use of pentobarbital sodium (nembutal) by mouth supplemented by the rectal administration of paraldehyde in olive oil. The preliminary report concerned our experience with a trial series of 50 cases. The present communication deals with the added information and experience obtained since then in a series of 300 cases.

An analysis of the first 50 cases, 30 primiparae and 20 multiparae is as follows:

1. The average duration of primiparous labors, after entrance to the hospital, was 10½ hours. The average length of multiparous labors was 5 hours and 20 minutes.

2. The average duration of amnesia and analgesia during labor was 9¼ hours for primiparae and 4½ hours for multiparae.

3. The average duration of amnesia following delivery was 8 hours for all cases. Complete amnesia throughout labor was experienced by 47 patients (94 per cent). Three patients (6 per cent) experienced partial amnesia. There were no failures.

4. Twenty-eight patients (56 per cent) showed very mild restlessness, moving slightly with pains. Eighteen patients (36 per cent) showed moderate restlessness, turning from side to side or occasionally attempting to sit up with pains. Four patients (8 per cent) showed a degree of restlessness which simulated that so commonly seen with scopolamine and barbiturates or with the straight barbiturates.

5. There was no maternal mortality and but one fetal death, a case of congenital monstrosity.

6. Forty-five babies (90 per cent) breathed or cried readily immediately following delivery and 5 (10 per cent) required mild resuscitation.

In comparison with the results furnished by the trial series, we now give an analysis of the present series of 300 cases:

1. Average duration of primiparous labor was 9 hours and 45 minutes. Average duration of multiparous labor was 5 hours and 40 minutes.

2. Average duration of amnesia and analgesia during primiparous labor was 8 hours and 40 minutes. Average duration of amnesia and analgesia during multiparous labor was 5 hours.

3. Average duration of amnesia following labor was 7 hours and 30 minutes. Complete amnesia throughout labor was experienced by 285 patients (95 per cent) partial amnesia in 11 cases (3.66 per cent). There were 4 failures (1.33 per cent).

4. As to restlessness 174 patients (58 per cent) showed a mild degree, moving slightly with each pain, 104 patients (34 per cent) showed a moderate degree turning from side to side and attempting to sit up with pains, and 22 patients (7.33 per cent) showed a marked degree of restlessness thrashing about, more or less noisy, and requiring added restraint.

5. There was no maternal mortality. There were 7 still births (2.29 per cent). Of these deaths 2 were apparently due to a tight cord about each infant's neck. One was due to prematurity and one was due to a premature separation of the placenta. One showed no possible cause for death. The 2 remaining infants were definitely macerated. Eight babies died during the first week after delivery. Of these there were 3 monstrosities, 1 congenital heart, 2 cases of congenital atelectasis, and 2 cases of erythroblastosis.

6. Of the babies born alive, 264 (88.54 per cent) breathed or cried readily immediately following delivery, and 34 (11.46 per cent) required mild resuscitation.

7. Method of deliveries 254 patients were delivered normally or by perineal forceps, and 28 patients were delivered by mild forceps. There were 6 breech extractions and 6 cesarean sections. A Scanzoni maneuver was performed in 3 cases and a similar number were delivered by internal podalic version.

The various methods employed today for providing obstetrical analgesia and amnesia are so well known to obstetricians that we feel even an enumeration of them to be unnecessary here. Suffice it to say that thus far no one method has been found to be applicable to all cases.

The barbiturates form the basis of most of the present day procedures. Sodium isoamyl ethyl barbiturate (sodium amytal) and pentobarbital sodium (nembutal) are being used, either alone or in combinations with such drugs as morphia, pentopon, scopolamine or rectal ether. The results measured in terms of amnesia, have been satisfactory with most combinations. But in terms of analgesia there are sufficient disadvantages to each combination. Failure to provide analgesia has resulted in varying degrees of restlessness on the part of the patient ranging from marked excitability to violent resistance, which, although the amnesia was good, the labor not prolonged, and the infants unaffected, has led to questioning the entire desirability of these drugs. On the other hand, where satisfactory analgesia has been obtained, this has been done in some instances, at the expense of the fetus, in that varying degrees of asphyxia ranging from slow breathing to definite respiratory depression could not be avoided.

The purpose of the procedure used in the series of cases under consideration was to conserve the beneficial effects of the barbiturates in producing satisfactory amnesia and analgesia and also to discover which drug when used in combination with the barbiturates, would eliminate both the danger of excitation to the mother and the risk of asphyxiation to the fetus. Paraldehyde has been found to satisfy these requirements.

Paraldehyde according to Cushtny is a polymer of ethylaldehyde. A more powerful narcotic than alcohol, it resembles the latter in its effects, but produces only rarely any symptoms of excitement. Even in large doses, it does not affect the heart directly an important consideration in cases of cardiac disease and produces no such effects on the protein metabolism as accompany the prolonged administration of chloral. It is observed that the pulse is somewhat slower and the carbonic acid exhaled is less than normal but these changes are not relatively greater in degree than those that occur in the course of natural sleep and must therefore be ascribed to the lessening of muscular movements. In fact, substantial quantities of paraldehyde have been taken without fatal results or with any more serious consequences than prolonged unconsciousness.

Paraldehyde is excreted in part by the lungs and for the most part in the urine. In this connec-

tion, a recent investigation (4) on the elimination of the barbiturates is of direct interest. It has been found that—

1. Amytal is excreted in the urine of humans and dogs only in traces, if at all following the administration of its sodium salts.

2. Under the same conditions, barbital and phenobarbital are excreted as such in the urine.

3. Most probably amytal and pentobarbital are rapidly and completely destroyed in the body.

It remains to be stated that paraldehyde, when used alone during labor even in very large doses, produces neither analgesia nor amnesia, but when applied in combination with the barbiturate group particularly nembutal it leads to satisfactory amnesia and analgesia.

The procedure in the present series of 300 cases differs from that used in the preliminary series, in that the alternative use of sodium amytal has been dropped and nembutal has been used entirely because of its more prompt action and because evidence has been found in this series that nembutal, when given early will not stop labor. Our procedure at present is as follows:

As soon as labor is definitely established, following the routine preparation and enema, the patient is given $4\frac{1}{2}$ grains of nembutal by mouth. This is followed in 15 minutes by 3 grains more. Now within 15 to 20 minutes of the second administration of nembutal, the patient is turned on her left side and is given a rectal instillation of 6 drams of paraldehyde in $1\frac{1}{4}$ ounces of olive oil. This mixture must be instilled high in the rectum, past the presenting part in order to avoid expulsion during a contraction.

This is facilitated by the use of an apparatus designed and described by McCormick (5). Equally satisfactory results may be obtained by using a 3 ounce glass aseptic syringe with a plunger. A No. 32 F rectal tube is attached to either apparatus. Care must be exercised to insert the rectal tube about 8 inches without allowing it to curl on itself. If the presenting part is engaged, the tube must be inserted above it.

The mixture is then injected quickly between pains. If the glass syringe is used, a quantity of air should be left in above the solution, sufficient to insure the emptying of the catheter but not enough to cause the air to enter the rectum, for this may lead to the explosion of the solution. Following the injection a pad should be held against the anus for at least 10 minutes.

If the patient is in hard labor, the injection is further facilitated by allowing the patient to inhale nitrous oxide and oxygen until asleep.

Within 3 to 4 minutes from the time of the injection, the odor of paraldehyde becomes perceptible on the breath of the patient and she quickly falls into a deep sleep, moving or turning from side to side during contractions and sleeping soundly in the intervals. The duration of the sleep depends upon the susceptibility of the patient and may vary from 3 to 12 hours. During the first hour after injection labor may become less active in many patients, but following this period labor is spontaneously resumed and appears to progress more rapidly than in those patients who are given no medication. In the majority of cases, with the application of the medication as described labor progresses to full dilatation, and the presenting part appears on the perineum and crowns. At this stage gas-oxygen is given and delivery is completed either spontaneously or with the aid of perineal forceps. The average patient in labor will begin to show signs of awakening in 4 to 6 hours after administration. At this time a rectal examination is made. (As a general rule, rectal examinations should not be performed for at least $2\frac{1}{2}$ to 3 hours after the rectal instillation, in order to avoid the expulsion of the solution.) If now we find that the patient still has several hours of labor $1\frac{1}{2}$ to 3 grains of nembital is given by mouth. This is accomplished by placing the capsule on the patient's tongue and then dropping a small quantity of water in her mouth by means of an ordinary glass drinking tube. As the patient swallows the water she will also swallow the capsule. If this does not succeed or if the patient vomits, remove the powder from the capsule, dissolve in water or in paraldehyde and inject into the rectum. Or, the ends of the capsule may be punctured and inserted directly into the rectum with equal effect. If this dose of nembital fails to quiet the patient, 2 to 4 drams of paraldehyde may be repeated by rectum. This will usually be sufficient to carry a patient through a 12 hour labor. Should labor be further prolonged, small amounts of nembital with or without paraldehyde, may be repeated as necessary.

If the rectal examination reveals that the cervix has been well taken up and four or more fingers dilated, with a low presenting part, then, instead of further medication, the patient should be carried along to completion of labor by means of gas-oxygen inhalations during contractions. It has been found that with the barbiturate group greater quantities of oxygen are required in combination with nitrous oxide than is usually the case with nitrous oxide oxygen administration. Most frequently equal parts of oxygen and nitrous oxide are required. The duration of ad-

ministration of gas-oxygen is much less than with the barbiturate-scopolamine group or with straight barbiturates. In addition patients do not resist inhalation anesthesia, a situation differing from that with other drug combinations, where patients become very restless and noisy and violently resist the application of the mask to the face.

Under this form of analgesia, most patients sleep soundly and quietly through labor and move more or less with pains. Furthermore the most restless of them are rarely noisy, as is the case with the use of scopolamine or of the straight barbiturate group. After a patient has been put to sleep, she should not be questioned by the attendant in order to find out whether or not she is feeling pain. Her reactions, without questioning, are sufficient evidence. Frequently a patient may complain of pain during contractions immediately fall asleep again in the intervals, and not remember her pains at all.

The question of dosage both of paraldehyde and of nembital is of importance. In the trial series we based the amount of paraldehyde in the rectal injection roughly upon the weight of the patient. At the outset of the series, while an endeavor was made to ascertain the optimum amount of paraldehyde, several patients were given as much as 12 drams at a single dose, with no undue effects. The dose of nembital varied from 6 to $11\frac{1}{2}$ grains, the latter in divided doses.

In the present series, the dosage of nembital used varied from 6 to 13 grains and that of paraldehyde from 6 to 12 drams. This dosage must be varied according to individual cases, for it has been found that while the initial dose recommended has carried a few cases successfully through 12 hour labors, in some cases it was necessary to repeat as early as 3 hours after the initial dose. There is thus a certain variation of susceptibility as one might readily expect. The time for repeating the medication must be judged entirely by the reactions of the individual patient and thus precludes the setting up of any hard and fast rules. Failure to repeat medication when indicated in a given case regardless of the time element, will give rise to unsatisfactory results, such as increased restlessness and diminished amnesia. For it stands to reason that in inverse ratio to the insufficiency of dosage, restlessness must increase and the possibility is prepared for a greater percentage of failure.

It has been stated earlier that medication is started as soon as labor is established. Our index for onset of labor is the regularity and character of the uterine contractions, regardless of the height of the presenting part or dilatation

of the cervix. Medication is frequently given with a floating presenting part and a cervix which is not taken up.

In conclusion it may be stated that the deductions and experiences drawn from the present series of cases give added force and significance to the advantages observed in connection with the trial series, namely

1. Production of prolonged amnesia and analgesia
2. Freedom of danger to the mother or the fetus.
3. Reduction of excitation to a minimum
4. Avoidance of delay in labor
5. Simplicity of administration

Articles appear from time to time in the lay press, making the assertion that painless labor in general is deleterious and is an added factor in increasing maternal and fetal mortality. On the contrary our experience with this method and also the experience of the Boston Lying In Hospital where experimental series involving most of the methods in vogue today have been carried on demonstrate that, due to the fact that patients can be allowed to remain in labor without suffering and with diminution of shock, for longer periods than is ordinarily the case there is less occasion for instrumentation and a possibility for a greater percentage of normal births. This tends to lower morbidity and mortality.

Certainly the border line patient can be given a much longer test of labor without discomfort and

shock, and not infrequently she may progress to a normal or easy instrumental delivery from below when otherwise a cesarean section would have been done.

In discussing the dangers of anesthesia during childbirth, one must differentiate between anesthesia used during actual delivery and drugs given to produce amnesia during labor. It is conceivable that a patient may die as a result of inhalation anesthesia during delivery when no medication was given to produce amnesia during her entire labor. Such a case, classified in the mortality statistics of those who die as a result of anesthesia used in obstetrics, should by no means be ascribed against painless labor.

In a series of over 1,200 cases in which various methods for producing painless labor were used, there is ample evidence to contradict statements which imply that there is prolongation of labor or deleterious effects on mother or baby. It must be emphasized that adequate dosage and constant nursing supervision is essential for satisfactory results.

REFERENCES

1. COBBETT, ARTHUR R. Pharmacology and Therapeutics 7th ed. rev., p. 215, 1918
2. MCCORMACK, C. O. A new rectal ether analgesia apparatus. *Am J Obst & Gynec*, 1930, 20: 411.
3. ROSENFELD, HAROLD H. and DAVIDOFF, REUBEN B. *New England J Med.* 1931 307: 366-368
4. SMOUL, KULTSCH, KERRY and SWANSON, J. *Pharmacol & Exper. Therap* 1933 49: 393-407

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE BILE ACID FACTOR IN GALL-BLADDER DISEASE

I^N recent years the progress of gall bladder studies has been rapid. Knowledge of the methods of formations of various kinds of stones has been put onto firm scientific basis. Cholesterol has been shown to be precipitated when the cystic duct is closed for short periods and the solvent the bile salts is absorbed. It has been ascertained that long continued cystic duct obstruction leads to the accumulation of calcium either on pre-existing stones or as *Kalkmilchgalle*. Furthermore the work of many observers has shown that blockage of the cystic duct results in the prompt onset of edema and thickening of the gall bladder with infiltration of its walls by round cells. However in order to explain the train of events leading to either stone formation or chronic gall-bladder inflammation a mechanism must be discovered to account for the temporary or permanent closure of the cystic duct. Thus far this has eluded us.

Recent demonstrations of the corrosive action of pure gastric juice suggests an inter-

esting parallel. If it is true that the gastric secretions *per se* have the power to cause extensive destruction of the mucosa which secreted them why not pay equal respect to bile? This is the strongest solution which the body elaborates. Few people realize that it contains in quantities up to 10 per cent a substance that is at least as toxic as hydrochloric acid. Bile salts have been shown to have the power to cause a fatal peritonitis, pleuritis or myositis in lesser concentrations and their exceeding toxicity for all body cells is well known.

Search for the exciting agent in gall bladder disease has proved very disappointing. Bacteria are now well known to occur in normal gall bladders in about the quantity and kind as often found in diseased ones. No mechanism of stone formation in open gall bladders is at hand. Closure of the duct by inflammatory edema is a *sine qua non* in each case. The absence of a proper flora has led some to search for a chemical cause. Both pancreatic juice and Dakin's solution are known to be capable of setting up a chemical cholecystitis of a severe type. One wonders why the bile itself which is acidified in the gall bladder to a hydrogen ion concentration below any other body fluid and whose known toxicity to tissue cells is so high has not been accused of mischief.

Attempts years ago to discover a cholesterol diathesis yielded the surprising result that starvation produced the highest bile cholesterol and that meat or general overeating did not significantly raise the bile cholesterol. The colossal experiment of post war starvation in Europe produced millions of examples of high

of the cervix. Medication is frequently given with a floating presenting part and a cervix which is not taken up.

In conclusion, it may be stated that the deductions and experiences drawn from the present series of cases give added force and significance to the advantages observed in connection with the trial series, namely:

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- 4 Avoidance of delay in labor
- 5 Simplicity of administration

Articles appear from time to time in the lay press, making the assertion that painless labor in general is deleterious and is an added factor in increasing maternal and fetal mortality. On the contrary, our experience with this method and also the experience of the Boston Lying In Hospital where experimental series involving most of the methods in vogue today have been carried on demonstrate that, due to the fact that patients can be allowed to remain in labor without suffering, and with diminution of shock, for longer periods than is ordinarily the case, there is less occasion for instrumentation and a possibility for a greater percentage of normal births. This tends to lower morbidity and mortality.

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REFERENCES

- CURRY, ARTHUR R. Pharmacology and Therapeutics 7th ed. rev., p. 235, 1918
- 2 MCCORMICK, C. O. A new rectal ether analgesia apparatus. *Am J Obst & Gynec*, 1930, 20: 4, 1
- 3 ROSENTHAL, HAROLD H. and DAVIDOFF, REUBEN B. *New England J Med* 1932 207: 366-368
- 4 SMOUL, KILTRICK, KERRY and SWANSON. *J Pharmacol. & Exper Therap* 1933 49: 393-407

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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FEBRUARY 1935

THE BILE ACID FACTOR IN GALL-BLADDER DISEASE

IN recent years the progress of gall bladder studies has been rapid. Knowledge of the methods of formations of various kinds of stones has been put onto firm scientific basis. Cholesterol has been shown to be precipitated when the cystic duct is closed for short periods and the solvent, the bile salts is absorbed. It has been ascertained that long continued cystic duct obstruction leads to the accumulation of calcium either on pre-existing stones or as *Kalkmilchgalle*. Furthermore, the work of many observers has shown that blockage of the cystic duct results in the prompt onset of oedema and thickening of the gall bladder with infiltration of its walls by round cells. However, in order to explain the train of events leading to either stone formation or chronic gall bladder inflammation, a mechanism must be discovered to account for the temporary or permanent closure of the cystic duct. Thus far this has eluded us.

Recent demonstrations of the corrosive action of pure gastric juice suggests an inter-

esting parallel. If it is true that the gastric secretions *per se* have the power to cause extensive destruction of the mucosa which secreted them, why not pay equal respect to bile? This is the strongest solution which the body elaborates. Few people realize that it contains in quantities up to 10 per cent, a substance that is at least as toxic as hydrochloric acid. Bile salts have been shown to have the power to cause a fatal peritonitis pleuritis or myositis in lesser concentrations and their exceeding toxicity for all body cells is well known.

Search for the exciting agent in gall bladder disease has proved very disappointing. Bacteria are now well known to occur in normal gall bladders in about the quantity and kind as often found in diseased ones. No mechanism of stone formation in open gall bladders is at hand. Closure of the duct by inflammatory oedema is a *sine qua non* in each case. The absence of a proper flora has led some to search for a chemical cause. Both pancreatic juice and Dakin's solution are known to be capable of setting up a chemical cholecystitis of a severe type. One wonders why the bile itself which is acidified in the gall bladder to a hydrogen ion concentration below any other body fluid and whose known toxicity to tissue cells is so high, has not been accused of mischief.

Attempts years ago to discover a cholesterol diathesis yielded the surprising result that starvation produced the highest bile cholesterol and that meat or general overeating did not significantly raise the bile cholesterol. The colossal experiment of post war starvation in Europe produced millions of examples of high

grade hypercholesterolemia, but no increase in gall stones. It is proverbial that gall stones result from overindulgence in rich foods especially meat, and this is known to cause an increase of bile acids in the bile. Thus a paradoxical suggestion seems justified i.e. that a high concentration of the solvent may provoke an irritation capable of closing the cystic duct and that this in turn results in the absorption of the solvent and the precipitation of cholesterol.

Experimental proof of such a hypothesis is wellnigh impossible on account of the fact that any manipulation of the gall bladder of an experimental animal causes the prompt onset of a severe cystitis. We are thus deprived of controls. However anyone who has once seen the widespread inflammation caused by inserting a sterile needle into a sterile gall bladder finds it difficult to believe that the inflammation is not a chemical one and due directly to bile itself. EDMUND ANDREWS

ACUTE PEPTIC ULCER PERFORATIONS—TO DRAIN OR NOT TO DRAIN?

IN order to evaluate this subject properly both the drainage of the peritoneal cavity and the continuous removal of stomach contents should be carefully considered.

Recently the dictum as regards peritonitis, When in doubt drain seems well on the way to being supplanted by the slogan "When in doubt, don't drain." It has been known for some time that drainage of acute peritonitis associated with a spreading infection is not as effective as drainage of an abscess associated with a late infection. In fact, as many experimenters have demonstrated the most that can be proved for drainage of the peritoneal cavity is that it helps localize pus in cases of spreading peritonitis. However in addition to this change of general surgical opinion as regards

peritonitis, many surgeons apparently have not given consideration to the inhibitory effects of hydrochloric acid on the growth of bacteria in evaluating the question of drainage. Of course, as is well known bacteria are found low in the intestinal tract more frequently than up higher where the influence of the hydrochloric acid inhibits their growth. In other words, the reaction of the peritoneum following these perforations is due to a chemical rather than a bacterial invasion.

In replies received from over one hundred surgeons, the following information was obtained:

About 20 per cent drain in every case. Most of these employ a drain through a remote incision. About 60 per cent drain only in the late cases, or in cases in which there is evidently definite pus formation. About 20 per cent close the abdominal wall in every case without any drainage. In other words, about 80 per cent do not use drainage as a rule.

It is our rule not to employ drainage in these cases, but perhaps our judgment has been somewhat warped by having had the experience of seeing in consultation 4 cases, which had been drained all 4 of which died with duodenal or gastric fistula. In 2 of these 4 cases the drain had been improperly placed to the site of the closure, but in the 2 other cases the drains had been placed remotely—in the flank and in the pelvis, respectively.

Much work has been done on the inhibitory effects of hydrochloric acid. Even in very minute quantities hydrochloric acid has a marked inhibitory effect on the growth of bacteria. This work has been done in the test tube with the bacteria usually found in the mouth and nose, as well as with cultures taken after introduction into the stomach and duodenum.

As a rule, very seldom are bacteria found in the normal stomach. In the stomach with an ulcer having the usual increased hydrochloric

acid content, bacteria are even less frequently found. In carcinoma with a lower or absent hydrochloric acid, bacteria are frequently found.

Cultures taken of the peritoneal cavity at the time of these acute perforations seldom show bacteria, and this in spite of the observations contained in a recent article stating that there is no such thing as an "aseptic peritoneal cavity." It might be that the proper cultural methods and media were not employed in making these examinations.

Neither bile nor pancreatic juice are well tolerated by the peritoneum but with these acute perforations the quantity of either is negligible. It seems to have been proved experimentally that the digestive action of pepsin tends toward the prevention of postoperative adhesions. This is especially true when used in a 0.4 per cent solution of hydrochloric acid.

Even inert foreign bodies injected into the peritoneal cavity stimulate first the defensive production of neutrophils and then an increase in the number of histiocytes.

After considering all these factors, there is apparently no justification for the institution of drainage of the peritoneal cavity in these cases except possibly in the very late cases showing definite pus formation. Of course, aspiration of the peritoneal cavity should be employed in all these cases while the perforation is being closed, and we all recall numerous cases in which large quantities of gastric contents have been removed, and the abdominal wall closed tightly. A few of the abdominal incisions will break down, but such an occurrence is a minor matter in comparison with a fistula. If the abdominal wall is closed with through and through "tension sutures" of some non absorbable suture material, infection of the abdominal wall will not be such a serious catastrophe, and this method will also prevent many future ventral hernias.

For some years some surgeons have advocated the immediate performance of a gastro-enterostomy following the closure of the perforation. The objectives of this procedure were

- 1 To make the postoperative discomfort of the patient less by preventing gastric distention

- 2 To aid in the future care of the ulcer, particularly in those cases which apparently would have a pyloric obstruction from the infolding of the ulcer as well as by the scar formation

In recent years the employment of the continuous suction with a small duodenal tube placed through the nose has removed the excuse for doing a gastro-enterostomy for the relief of gastric distention. The use of this tube also removes, more effectively than any other means we have, any retained old blood or other gastric residue.

In only about 10 per cent of these cases is it necessary later to do any operative work to effect a cure. This we believe is due to the improved medical care now given by the internist, and even of more value is the fact that the patient who has had the experience of having had a perforation is far more willing to take the medical cure than is the patient with an ulcer who has not had such an education.

Resections, or any type of plastic procedures, must necessarily be done with tissue which is infiltrated, and therefore unsatisfactory for suturing. In fact with desperately ill patients, it is sometimes advisable simply to plug the perforation by suturing omentum into the opening.

It is wise for the surgeon to remember that the operation is usually a life saving attempt and that the patient should not be subjected to any unnecessary procedure.

HUGH H. TROUT

EARLY AMERICAN MEDICAL SCHOOLS

THE FACULTY OF MEDICINE OF MCGILL UNIVERSITY

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THE Medical Faculty of McGill University is the successor of a brilliant period of educational work which established it, in the third decade of the nineteenth century as the first medical school in Canada. This was the organization of the Montreal Medical Institution, an earlier teaching body of which the McGill Faculty is the direct successor and which was founded in the year 1822 by the first medical staff of the Montreal General Hospital. Drs. William Patterson, John Caldwell, Andrew F. Holmes and John Stephenson, the two former British military surgeons of reputation and experience, the sole or among Canadians who were graduates of Edinburgh University, had qualified for the degree in surgery from apprenticeship and in some years of hospital study.

Organization is a remarkably broad and effective one, with the complete cooperation and under the expert and administrative of Lord Dufferin the best possible medical young men were being trained at once in continuity and carried on with a full curriculum but without interruption until the year 1849. At this time a critical juncture had arisen in the affairs of McGill College which, though founded in 1828 by the will of James McGill and incorporated in 1829 as yet existed only on paper as nominal teaching staff having been appointed in 1829, one of whom, the distinguished Dr. James Fergusson of Glasgow, known an Edinburgh graduate, did not even reside in Montreal. It was however in order to fulfill the intention of the will and to secure the bequest of the founder it had become essential for the university to initiate academic activities, although owing to large loan incurred by the benevolence of the great financiers were financially lacking. In this dilemma, the attention of the Royal Institution for the Advancement of Learning, a body framed by Act of Parliament in 1808 and the trust under the will, was directed to this sturdy young teaching body of established reputation active in its midst, and correspondence was accordingly initiated,

with the result that, at the first meeting of Governors of "Burnside University of McGill College" the members of the Montreal Medical Institution were formally "engrafted upon" the College as its Medical Faculty. "It being understood and agreed upon between the said contracting parties, that, until the powers of the Charter would be at end, one of their number only should be University professor and the others lecturers." This historic event took place on June 29, 1829 at Burnside House the residence of the Founder in the presence of a distinguished gathering, William Patterson being appointed professor and Caldwell, Stephenson and Holmes lecturers in their respective subjects. Through this arrangement the new Faculty by its activity literally saved the property of James McGill to the educational purpose for which it was designated and thereby rescued the College from protracted litigation, if not from final defeat.

The medical school was thus the pioneer Faculty in the University and it continued to be the only one in active operation during the next 25 years of the latter's existence. It was also through its devoted secretary Dr. John Stephenson the instrument whereby the requisite authority to confer degrees was obtained. Its founders are therefore to be regarded as the founders also in the academic sense of the University as a whole. In these particulars its record is, so far as we know unique in the history of early medical schools on this continent.

In other ways also, the story of its origin reveals an honorable and heroic past, that establishes a great tradition. It was founded in a time when political dissensions were rife, under great material difficulties and at the cost of much personal labor and sacrifice by men who, as in the case of the Medical Faculty of Pennsylvania, were of high professional status and, following the method of the parent Edinburgh school made clinical instruction at the bedside an integral part of the hospital routine and an essential feature of their curriculum. So faithfully was this principle ad-

hered to by this early teaching staff and their successors, that it remained the hall-mark of this Faculty, and, during the ensuing 50 years, the 'clinical advantages' of McGill were recognized both in England and America as among the greatest available. It was indeed this early reputation that brought it, at a later period the distinction of numbering among its graduates and on its early professionate one of the greatest clinical teachers and leaders of medical thought of his time, William Osler, who graduated from McGill in 1872, and held the appointment of pathologist to the Montreal General Hospital and the chair of the Institutes of Medicine here during the first 10 years of his academic life (1874-1884). In Osler's own view this early experience was fundamental to his later progress to the status of a great clinician, and it permeates and lives again in nearly all his later medical publications. His loyalty to his Alma Mater and his acknowledgment of the value of this early influence in shaping his later career found fitting expression after his death in 1919, in the gift under his will to his old school of his great collection of books on the history of medicine, now housed in the Osler Library of the Faculty, and in the touching bequest of his ashes, which repose there behind his portrait, surrounded by the most beloved of his books.

The following is a brief outline in detail of the sequence of these events

THE RISE OF THE MONTREAL MEDICAL INSTITUTION AND THE MEDICAL FACULTY OF MCGILL UNIVERSITY

As indicated previously this Faculty was the result of three different public movements emanating from the philanthropy and foresight of the English speaking citizens of Montreal in the early years of the last century. These were the foundation of the Montreal General Hospital, the organization of the Montreal Medical Institution and the establishment by James McGill of his University.

The story goes back to the year 1819. Montreal was at that time a thriving little city of some 20,000 inhabitants, with a rapidly increasing English speaking immigrant population, among whom disease and destitution were distressingly prevalent, and with educational establishments and hospitals dating from the old French régime and adapted only to the needs of the French Canadian population, for whom also the latter provision was entirely inadequate. In that year the "House of Recovery" a small four roomed cottage which had been opened in the previous year 1818 by the Female Benevolent Society for

the care of the Protestant indigent sick, was replaced by a larger building situated on Craig Street and containing 24 beds, to which the name "*Montreal General Hospital*" was first given. It was provided with a code of regulations and an attending medical staff and "one Dr John Stephenson was installed as House Surgeon, to visit the Hospital every day in case of accidents."

From now on events moved quickly. The site of the present Montreal General Hospital was bought by private generosity in August 1820 and the Government was memorialized for support, on June 6, 1821, the corner stone was laid and on May 1, 1822, the central block of the present building erected by funds obtained from public subscription, was thrown open to patients, with an attending staff of the men already named with the addition of Henry P Loedel who resigned a few months later.

The Montreal Medical Institution. From the beginning it was clearly formulated that the hospital was to be used as the actual headquarters of a medical school and for the instruction of students, who were to be admitted freely to the wards for teaching and study. That this was understood as far back as 1819 is evident from the discussions in the House of Assembly in that year. Thus Dr Charles Perrault speaking in support of the motion introduced by Mr Molson for the establishment of a public hospital in Montreal, said "Independent of the good which must result from the establishment of a well regulated hospital to humanity at large, another no less important object is obtained by establishing in such an institution a school for teaching the healing art in all its branches." The initiative in teaching was taken by Dr Stephenson, whose name appears in the Hospital minutes on August 6, 1822 as receiving permission to advertise lectures for the ensuing winter in the subjects of anatomy practical anatomy surgery, and physiology with an introductory lecture to be delivered by himself at the hospital on October 7, 1822. Advertisements to this effect ran through the *Montreal Gazette* for the entire year, and the announcement of a course of 'experimental lectures on chemistry given by Dr Holmes at the house of Mr Alexander Skelton, appeared on December 14, 1822 and was continued until the following spring.

The first steps in the organization of the Montreal Medical Institution itself were taken on October 20, 1822 when at a meeting of the medical officers of the hospital held to consider the expediency of establishing a medical school in this city, Drs. Stephenson and Holmes were deputed 'to draw up the considerations that

seemed to warrant such an endeavour at this Hospital. This historic document was accordingly submitted a week later and approved. Its opening words are of great interest, as are also the references to the Edinburgh School and to the part which the new Institution was to play a few years later in the stabilisation of the infant college of James McGill. It read in part as follows:

The Medical Officers of the Montreal General Hospital, having seen the great difficulties which the student of medicine in this country has to encounter before he acquires a competent knowledge of his profession knowing the great inconvenience resulting to many from the necessity at present existing of spending several years in a foreign country to complete a regular medical education, and being convinced of the advantage which would result from the establishment of a medical school in this country and considering that the Montreal General Hospital affords the student a facility of acquiring a practical knowledge of *Physic* never before enjoyed in these Provinces, an advantage which will be greatly enhanced by the establishment of lectures on the different branches of the profession, have met to consider of the possibility of founding such an institution in this city.

They consider that the Montreal General Hospital is an institution which favors much the establishment of a school of medicine in this city—it affords the student a facility of acquiring a practical knowledge of *Physic* never before enjoyed in this Province—an advantage which will be greatly enhanced by the establishment of lectures on the different branches of the profession.

They are further encouraged to attempt the formation of a medical seminary when they reflect that the medical school of Edinburgh, the basis of which they would adopt for the present institution, now justly considered the first in Europe, is of comparatively recent formation, it being little more than one hundred years since the medical lectures were first delivered in that city—and the early history of the Royal Infirmary of Edinburgh is not dissimilar to that of the Montreal General Hospital.

In the event of the establishment of a classical and philosophical seminary in this city the two institutions would be mutually benefited.

To ensure the success and permanency of such an institution it would be highly desirable that the persons composing it should be associated by a Royal Charter or Act of Incorporation.

On November 2, 1822 a copy of this Memorandum signed by all five members of the medical board of the hospital was forwarded the governor-in-chief, Lord Dalhousie, by Dr Robertson with a covering letter in which he suggested that in order to give the new institution legal status, the board of medical examiners for the District of Montreal should be reconstituted and made to consist of the medical officers of the Montreal General Hospital. Lord Dalhousie, whose enlightened attitude in educational matters was well known approved and on February 22 a Royal Commission was issued appointing 'the said Wm Robertson William Caldwell, John Stephenson, A F Holmes and H P Loedel

any three or more of you to be the sole Medical Examiners for this District."

On February 4 1823 an advertisement announcing the prospectus of lecture courses for the ensuing session 1823-24 for publication in the newspapers "of the Lower and Upper Canadas," was submitted to His Excellency and duly approved. It was headed "The Montreal Medical Institution and after repeating the introductory paragraphs in the Memorial of Holmes and Stephenson upon the imperative necessity for the establishment of this School, it continued:

The circumstances which rendered the success of such an institution probable and the measures intended to be adopted for carrying the same into effect having been submitted to His Excellency the Governor-in-Chief he was pleased to signify his entire approbation of the plans.

"It is therefore resolved to deliver lectures on the following branches of the profession to commence in the second week of November ensuing: *Anatomy and Physiology* J Stephenson, M.D. *Chemistry and Pharmacy* A F Holmes, M.D. *Practice of Physic* W Caldwell, M.D. *Midwifery and Diseases of Women and Children* W Robertson, M.D. *Materia Medica* H P Loedel, Esq. *Surgery* J Stephenson, M.D. In the course of the summer 1824 *Botany* A F Holmes, M.D."

Montreal, 4th February 1823

On August 23 1823 following the resignation of Dr Loedel from the Board of the Hospital and Institution was received and Dr Wm Lyons was appointed in his place, a medical library was established and an announcement of the lecture courses for the session 1823-24 to "commence at the House of the Institution No. 20 St James Street, was ordered published in the Montreal Quebec Kingston and Toronto papers. Figure 2 is a photostat copy of this advertisement from the *Quebec Gazette* of October 23 1823. It effectually settles the date of the first session of the institution.

The original minute book of the Montreal Medical Institution containing all its proceedings and copies of correspondence with the Government during the 2 years of its organization has, fortunately for posterity been preserved in the archives of the Faculty constituting its greatest treasure. These minutes were transcribed in part in an Introductory Lecture delivered at the opening of the session 1866-67 by Dr Archibald Hall¹ and they have been published in full by the writer² as an appendix to her 'Historical

The Past, Present and Future of the Faculty of Medicine of McGill University. By Archibald Hall, M.D. F.R.C.S. Professor of Midwifery and Diseases of Women, McGill University. Secretary of the Quebec Society of London, Associates of the College of Physicians of Philadelphia, etc. DUBLIN: BURNS 1867 also, Canada M.J. 1864-67, p. 249-250.

An Historical Sketch of the Medical Faculty of McGill University. By Maudie K. Abbott, B.A. M.D. Montreal M.J. August, 1904 pp. 94-95 also, Quebec Printing Co. pages, 121-122. Appendix 271, pp. 272-404.

Sketch of the Medical Faculty" which appeared in 1902

The matter of the incorporation of the Medical Institution was dealt with subsequently. In the summer of 1826, at the instance of Lord Dalhousie a form of charter was drawn up and presented through him to the Solicitor General for an opinion. The reply, received after a delay of 18 months, was unfavorable objections being raised on the ground that the school was not associated with any seminary of learning nor had it any endowment or foundation. After pleading in vain the similar beginnings of the College of Surgeons of London, Edinburgh, and Paris the officers of the institution suggested to the Government, as a means of obviating their difficulties, "the appointment of the members of the said Institution as Professors of the University to be established at Burnside, near that city one of the Colleges of which is established by Royal Charter, dated March 31 1827, and called the McGill College." As indicated previously this proposal came at the psychological moment for the young University of James McGill, and accordingly the memorable step was taken which gave the Medical Institution a charter and foundation and McGill an active and highly qualified medical faculty. As a result also the estate of Burnside was handed over to the university by the law courts in 1829 but the financial part of the bequest remained for several years longer in the possession of the contestant and residuary legatee, François Desrivières, the son of the widow of James McGill.

The Medical Institution as a Faculty of McGill
The first session in which the old medical institution functioned under its new guise as the Medical Faculty of McGill University was that of 1829-30, when it opened with the same teaching staff and some 25 students, its inheritance from the earlier school. The following year, on October 29 1831, a memorial was presented by its members to the Legislature asking that measures be taken to give effect to the authority granted by Royal Charter for the conferring of degrees to the candidates who had successfully passed the examinations and fulfilled the requirements of this school. On November 7 following the Solicitor-General advised that under its charter the university must first secure the royal sanction of its statutes. Two days later "the statutes, rules, and ordinances of the Medical Faculty of McGill University" was presented at Quebec in person by Dr Stephenson and forwarded to London. The reply, received on July 23 1832 conveyed His Majesty's approval of these stat-

utes and sanctioned the conferring of the title of "professor" on all four members of the faculty. The first McGill degree was thereupon conferred on May 24, 1833 in medicine, on Mr W. Logie. In that year also the Governors passed a resolution "that the Medical Faculty be authorized to use all the means necessary to forward the suit now pending touching the ten thousand pounds bequeathed by the Honorable James McGill to this College," and appointed Dr John Stephenson university registrar. Shortly thereafter, the money so long withheld, was at last paid over with accrued interest. It now amounted to £22,000. Other changes promptly followed. Edinburgh which had from the first given official recognition to the Montreal Medical Institution by counting two of the latter's courses as equal to one of her own, now at once, on the joining of the school to the university in 1829 accepted the certificates of the faculty at their face value. The other British schools immediately followed this lead. Almost from the beginning also the obligatory course of study was changed to 4 from 3 years, each consisting of a 6 months session.

THE FOUR FOUNDERS

Before proceeding to later developments a glance is necessary at the life history of the four men who figured so largely in the foundation of this school and university.

William Robertson (1784-1844) who was called by his biographer¹ the Nestor of the famous quartette, was born at Kindrochet, Perthshire. He saw military service at a very early age, having been an ensign in a Highland regiment at the age of 13, and he qualified in medicine at Edinburgh while still under age. He came to Canada in 1806 and served through the War of 1812 in the capacity of surgeon to the 41st Regiment, and he was present at the battle of Queenstown Heights and the storming of Fort Niagara. He retired from the army in 1815 and settled in Montreal and took, as we have already seen, a prominent part in the epoch-making educational developments of the next 30 years. He was a member of the Board of examiners from 1817 on and was from 1829 the official head of the Faculty and succeeded Dr Caldwell in the chair of medicine in 1833. He led the arduous life of a family physician with the largest practice in the city and was distinguished by his thoroughness and punctuality, generosity and charitable character which made him universally beloved.

William Caldwell (1782-1833) had been a surgeon in the 13th Regiment of Dragoons and was a veteran of the Peninsular War. He was born in Ayrshire and held the M.D. of Marischal College, Aberdeen University. Retired from the army after the War of 1812 he took out his license in the District of Montreal in 1817 and had settled in that city before 1819. His name is famous locally because of a duel which he fought in that year as the result of a quarrel with a Mr O'Sullivan who had opposed the petition presented in Parliament by the "Inhabitants of

¹William Robertson By R. F. Reith, McGill University 1902 pp. 1-175

SURGERY GYNECOLOGY AND OBSTETRICS

Montreal on February 19, 1819, praying for the establishment of an English public hospital. Both participants were wounded but recovered. Dr Caldwell was the first lecturer on the principles of medicine in the McGill School. He served during the great cholera epidemic of 1832; but died of typhus contracted in the wards of the General Hospital in the following year.

Andrew Fernandez Holmes (1797-1866) is probably the most outstanding from the scientific standpoint of the four and with Dr Stephenson has been universally considered one of the two real founders of the Faculty. He was born at Cadix, Spain, where his parents were detained as prisoners of war from a British vessel captured on its way to Canada where they arrived only in 1801. Given a good classical education at Mr. Skelton's famous school in Montreal, he was articled at the age of 14 to Dr Daniel Arnold, known at that time as the dean of the profession in Lower Canada. Five years later in 1816 he presented himself for the Licentiate and qualified by examination for the practice of "physic" as well as surgery.

Proceeding immediately thereafter to Edinburgh, he gained his diploma from the Royal College of Surgeons there in 818 and in 819 the degree of M.D. of that university. Along with John Stephenson he studied also in London, Paris, and Dublin. In 818-9 he was made an extraordinary member of the Royal Physical Society and in 820 a non-resident member of the Wernerian Society of Natural History of Edinburgh. An entering worker in his profession, he was also an expert botanist and mineralogist and made large collections along both lines which are still housed in the University Museum at McGill, the Holmes Herbarium of Canadian Plants, containing 500 species collected by him in the vicinity of Montreal and representing the entire flora of the district. A catalogue of this was published by Dr. James Barnston in the *Canadian Naturalist* for 1859.

Dr. Holmes was also a scientific author of reports and has many articles in British and American as well as local journals, written in a polished style and classical English and based on accurate and discriminating observation of facts as such. The Cholera Epidemic as it appeared in Montreal in 1832 and Cholera Diarrhoea as it appeared in Montreal in 1833. *Medical Journal*, 833, 8, 51-65, 230-238, and that on a Unique Form of Cardiac Malformation" published in the *Boston literature* in the *Trans. Med. Soc. Edin.* (will unique in the return from Edinburgh, Dr Holmes was for 5 years in partnership with his former teacher Dr Arnold. On his organization of the Montreal Medical Institution he was until 1843 when he succeeded Dr Robertson as professor and in 1854 he became the first dean of the medical faculty of McGill University. He died in business, when in the middle of calling a meeting for the latter. In 1864 thus today the highest student award within its gift, in memory of their late dean, "than whom no man ever lived more conscientiously or died more beloved."

John Stephenson (1797-1842). The close friend and life long co-worker of Dr Holmes, and, in the words of an eminent contemporary, "the man to whom above all others we owe McGill College." He was a native Canadian, having been born in Montreal. He was articled under Dr William Robertson until July 1817 when having finished his apprenticeship he joined Holmes in Edinburgh. He took his degree of M.D. from that University in 1820, having meantime qualified for the license of the Royal

College of Surgeons in London in 1819. On returning to Montreal in 1821 he immediately entered upon a large practice as a surgeon and he lectured on this subject and on anatomy at the medical school from 1823 to 1835 and after this on anatomy alone until his death. As secretary of the medical institution and faculty from 1823 and devoted services and it was universally recognized by his contemporaries that the successful issues to the university of the contest over the will of James McGill was chiefly if not entirely due to his energy and influence. He was a man of culture and of great industry and integrity and an enthusiast in the cause of medical education. As a surgeon of experience he had the confidence of the public and his name is said to have become in this regard as a household word in the homes of all nationalities in this city.

PERIOD OF GROWTH AND DEVELOPMENT

The tragic death of Dr Caldwell from typhus, in 1833 made the first break in the ranks of the four veteran teachers. The gap was temporarily filled by Dr John Racer, and on his removal to Quebec 2 years later in 1835, by the appointment of G. W. Campbell to the chairs of midwifery and surgery and Archibald Hall to that of materia medica. Both these men were graduates of Scottish Universities, Dr Campbell of Glasgow and Archibald Hall an M.D. of Edinburgh and their activities in the succeeding 30 odd years were probably the most essential factors in the rapid expansion and stabilization of the medical school that now ensued, and in the organization of the Canadian medical profession on a conservative educational basis. Dr Campbell held both his chairs until 1842 and then resigned from midwifery but retained that of surgery which he filled until 1875 a period of 40 years. As a member also of the visiting staff of the Montreal General Hospital during this entire time, he is said to have laid the foundation, by his great skill and distinguished abilities, of the high reputation enjoyed by this hospital as a school of practical surgery. In 1860 he succeeded Dr Holmes as Dean, an office he retained until his death. Dr Archibald Hall (1812-1868) was likewise transferred in the reorganization of the faculty that took place in 1842 on the death of Dr Stephenson and the retirement of Dr William Robertson to the chair of chemistry and in 1854 he succeeded, on the death of Dr McCulloch, to that of midwifery, a position to which he had been specially trained, having served his apprenticeship under Dr William Robertson, the most accomplished accoucheur of his day. Dr Hall's most important contribution lay however in the field of medical legislation and Canadian medical journalism of

See the charming article entitled "Reminiscences of the Medical School of McGill University" with slight alterations and additions of the members of the Medical Faculty of 1842-50. By Dr C. MacCallum, M.D. M.R.C.S. Edin. McGill University Magazine, 1921, 24-33.



Dr. William Robertson, 1784-1844 official head of the Faculty (1839-1844) and first professor of medicine.



John Stephenson, M.D. F.R.C.S., 1797-1842 first registrar of the faculty and university



Andrew F. Holmes, M.D., LL.D., 1797-1860 official head of the faculty from 1844 and first dean (1854-1860)

W. Caldwell
A. F. Holmes
J. Stephenson
W. Robertson

Fig. 1. Portraits of three of the four founders of the Montreal Medical Institution and medical faculty of McGill University from oil paintings in the possession of the McGill medical faculty and signatures of the four founders of the medical faculty: W. Caldwell, M.D. (1782-1833), A. F. Holmes, M.D. John Stephenson, M.D. and W. Robertson. (From their Memorial dated October 29, 1831 praying that the governors of McGill College be given authority to confer degrees.)

which latter he may be said to have been the founder. A keen and incisive writer with a clear sense of educational values and a determined though generous opponent of what he considered professional irregularities, he took a leading part in the bitter medical polemics of the day that waged, especially in the years 1847-51 about the rights or otherwise of incorporated medical schools to confer diplomas carrying the right to the license to practice without further examination or university degrees. As editor and owner from 1845 on of that grand old periodical the *British American Journal of Medical and Physical Science* he fought in this and other ways the battle of his college and of the profession at large and became the intrepid defender of the rights

and interests of both. In 1855 he was made vice president and in 1859 president of the "College of Physicians and Surgeons of Canada East" whose Act of Incorporation and Charter he had guarded so vigorously and well. He was also an honorary fellow of the Royal Obstetrical Society of London and an associate of the College of Physicians of Philadelphia.

The real growth of the medical school did not begin until 1841-42 when the yearly attendance of students, which had averaged 25 up to this time, rose to an enrollment of 39. For some time thereafter progress still remained slow, there being only 44 students in 1849-50. In 1850-51 however, there were 53 enrollments and from then on the numbers advanced steadily to 108 students

MONTREAL MEDICAL INSTITUTION

THE Lectures will commence at the House of the Institution, No 20 St James Street, on MONDAY the 10th of November at 11
 Medicine, 11 A.M. and Obstetrics, Thursday 11th, at 9 A. M.
 P.M. 1 P.M., Day
 Principles of Surgery, Thursday 11th 110 A. M.
 W. Mc GILL, M.D.
 Chemistry and Pharmacology, Monday 10th, at 11
 A. M. J. HOLMES, M.D.
 Anatomy, Physiology and Surgery, Monday 10th at 2 P. M.
 J. Mc GILL, M.D.
 Midwifery and Diseases of Women and Children, Wednesday 12th at 2 P. M. W. HOLMES, M.D.
 Lectures on Friday will given by Dr. HOLMES, during the Summer
 A B - Visiting lectures at the Montreal General Hospital & Rooms - 11th October

Fig 3. Advertisement from the *Quebec Gazette*, October 13, 1853, announcing the first courses of the Montreal Medical Institution for the ensuing session 1853-54. (The sign "B" written across this advertisement was inscribed by the publishers of the paper and indicated that the charge for its insertion was one shilling.)

in 1859-60 141 in 1869-70 166 in 1879-80 261
 in 1889-90 312 in 1892-93 401 in 1894-95 and
 650 in 1902-03. At the present time under the limitation of the yearly registration to 100 students, the enrollments at the opening of the present session 1934-35 numbered 480.

The decided impetus that thus took place in the middle of the last century may be ascribed to three different causes. First of these was the growing superiority of the clinical teaching consequent on the activities of an enlarged and competent hospital staff among whom must be especially mentioned Robert L. Macdonnell, a licentiate of the Royal College of Surgeons of Ireland who though only 5 years on the staff of hospital and college left upon these a lasting impress. Trained in the distinguished school of clinical medicine of the Meath Hospital in Dublin where he served under the celebrated Graves and Stokes, he became deeply imbued with their teachings and added to a familiarity with the current medical literature and an intimate knowledge of the methods of investigating disease a valuable practical experience gained in their wards as an assistant of these great clinicians. On his appointment to the staff of McGill in 1845 he immediately set about introducing their methods at the Montreal General Hospital with a contagious enthusiasm that quickly resulted in the reorganization on a permanent basis of the teaching in clinical medicine along lines that placed the McGill School on a plane with the most advanced European and American institutions. Other factors of importance in the acquiring of this reputation were the eminence already referred to above, of G. W. Campbell as a teacher

skilled in the practice of surgery of Drs James Crawford and Sewell in clinical medicine, as also the brilliant William Sutherland and last but not least the sterling qualities of Dr Michael McCulloch of Glasgow an L.R.C.P. of London and an honorary M.D. of McGill, who was professor of midwifery from 1842-54, and who in those pre-aseptic days was yet able to reduce the mortality at the Montreal Maternity Hospital to 1 death in 354 cases.

No less important was the emergence at this time of the University itself from the depression that had until then engulfed it, to an era of relative prosperity and financial security under the powerful administration of McGill's first great principal, Sir William Dawson, whose appointment dates from October 1855. From the first he took a highly constructive interest in the medical faculty. The appreciation with which he viewed its pioneer labors was expressed in his inaugural discourse at this time as follows:

"It is second to none in America and presents one of the noblest instances anywhere to be found of the results which may be attained by the almost unaided exertions of able men thoroughly devoted to their work. Its announcement for the present session (1853-56) shows a staff of 12 Professors, a library of 2,000 volumes, an extensive series of Museum preparations, and excellent arrangements for hospital practice and dissection. It has sent forth since the conferring of its first degree in 1833, 150 graduates. Nothing in connection with education in this city offers more just cause of pride or hope for the prosperity of our Institution than the success which has attended the labours of the Medical Faculty."

The third element in the expansion of the Faculty which began with the sixth decade of the last century and has never ceased up to the present time is described in some detail below. It was the removal of the school to a more convenient location in the vicinity of the hospital and to the occupation of a building in its own personal possession, the old Coté Street School.

THE BUILDINGS OCCUPIED BY THE MCGILL MEDICAL SCHOOL

The first lectures were delivered, as its advertisements state (Fig 3) at the house of the Institute "No 20 St. James Street, a small building (Fig 3) on the north side of what is now Place d'Armes Square. The School remained here for some years and then removed to a tall narrow building on Fortification Lane just behind the present Bank of Montreal. Later some time after 1833 the Faculty established itself in a large three story brick building which is still standing on the west side of St. George Street, three doors above Craig Street. The accommodation here



Fig. 3 "No. 20 St. James Street," believed to be the first home of the Montreal Medical Institution and the medical Faculty of McGill University. (From a drawing by Professor J. C. Simpson, in the possession of the Historical Medical Museum of the School)



Fig. 4. The Coté Street Building, owned by the Faculty of Medicine and occupied by it from 1851 to 1872. It was from this building that William Osler graduated in the spring of the latter year.

seems from the first to have been unsatisfactory but the question of ways and means was at this time of paramount importance. It was probably on this account that the medical faculty was invited to occupy in the year 1845 the Arts building of the university itself erected in 1843 and the only one except the principal's office then standing. The first session of the medical school in the college building was that of 1845-46 and there it remained for the 5 succeeding years. During this time the student body suffered greatly under the inconvenience of the location which at that time lay far out in the country for the university grounds were a mile and a half beyond the then city limits. A lecture at the college ending at 12 noon a rush through often untravelling winter snow and a vain attempt to dine and attend a one o'clock clinic at the Montreal General Hospital were a daily trial even to the bravest as also were the eight o'clock morning lectures, to be reached frequently only through almost impassable snow drifts, and the attendance by night in the dissecting room on the top floor of this lonely building which lay far removed from other dwellings and was lighted only by candles. On March 19, 1847, the students set forth these disadvantages in a petition asking that the lectures be again given in town. Action was not taken, however until the spring of 1851, when the St. Lawrence School of Medicine, a rival institution

with headquarters in the city, was organized. The McGill School then decided to leave its out-of-the-way situation and return to town rather than risk competition under such unfavorable circumstances. Three members of the faculty, Drs. Campbell McCulloch and Sutherland accordingly undertook to erect a suitable building at their private expense and to rent this to the faculty, the rent received to be 10 per cent on the outlay and the faculty to pay the assessments. The lot purchased for the purpose was on the east side of Coté Street in the close vicinity of the Montreal General Hospital, and a brick building, No. 15 Coté Street, was promptly erected upon it, in time for the opening of the session 1851-52. Here the school remained until the autumn of 1872, and here during these 21 years passed in an unbroken circle of steady work and gradual progress, the sure foundations were laid for the later era of relative prosperity that ensued. Here in 1853 all ten of its lecturers were appointed professors, and here in 1854 Dr. Holmes became its first dean. New appointments were made and new courses opened, examinations divided into primaries and finals, a summer session established and the number of students rose from 64 in 1851-52 to a roll-call of 184 in 1866-67. Here Dr. R. Palmer Howard, professor of medicine and dean of the faculty from 1882 on, by his

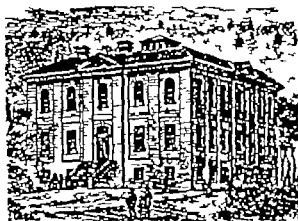


Fig. 5. The first building of the McGill medical faculty in the University grounds. Erected in 1872 and destroyed with its extensions by fire in 1907.

sound and up-to-date teaching at the bedside in close correlation with the autopsy findings inspired with his own zeal a galaxy of youthful intellects, and gave the first impetus to the foundation of a chair of pathology. Here Osler graduated, George Ross and Richard L. Macdonnell taught, and F. J. Shepherd was an undergraduate—members all of a group of eager young clinicians who were a few years later to take a leading part in the coming of age of scientific medicine and surgery on this continent.

In the year 1860 the university took over the Coté Street building and made extensive improvements in it at a total outlay of £9,360 of which £1,200 was paid the proprietors for its purchase and the balance expended on the enlargements that had become necessary. The number of students continued to increase steadily however and again overflowed its capacity so that further space became again essential. And now the faculty themselves began to look upon the university grounds as their proper home. The rapid growth of the city to the westward had removed the old objections to this location, and even rendered it a more suitable spot than a place nearer the hospital, in what promised to become one of its poorer quarters. Accordingly after considerable preliminary negotiation the university decided in the year 1871 to build within its own precincts for the accommodation of its medical faculty. Accordingly a square stone building of commodious proportions was erected by the Governors at a cost of \$27,000 on the University Street side of the college property and thrown open for occupation in the autumn of 1872 (Fig. 5). Most of the university funds had been de-

rived from the sale of the historic Burnside House, the faculty on its side binding itself to keep the building insured up to \$16,000 and to pay all assessments, taxes, and repairs.

The material advancement of the School after this epoch-making step is measured by the extensions of this modest single block of 1872 through three successive additions—that of 1885 for the accommodation of 300 students, that of 1895-96 for the establishment of pathological and public health laboratories to the fine new building of 1902 (Fig. 6). Funds for these operations were obtained from the Lean Choi endowment of \$50,000 given by Lord Strathcona in 1882 and the G. W. Campbell Memorial Fund of \$50,000 raised among graduates and friends of the University in 1883 from \$60,000 contributed by Mr. J. H. R. Molson in 1893 for building and equipment of the laboratories, rendered necessary by the endowment earlier in the same year by Lord Strathcona of the chairs of pathology and public health with \$100,000. In 1899 the same generous donor contributed another \$100,000 and this together with \$3,000 from the faculty funds was all expended upon the construction of the "new" building or extension of 1901-02.

In 1907 this fine Medical Building the pride and joy of the Faculty was destroyed by fire, the only part remaining intact being the extensions for laboratories and lecture room at its rear and the library and historical part of the Museum. In 1911 the present "Strathcona Medical Building" was erected from funds obtained from the fire insurance and \$450,000 from Lord Strathcona, on a site farther up on the hillside commanding a fine view of the city and in closer proximity to the Royal Victoria Hospital which institution had been founded under the aegis of the university by Lord Strathcona and Lord Mount Stephen in 1894. This "new Medical Building," a handsome stone structure of modern construction, was made to house the administration offices, library and museums, and the departments of anatomy, pathology, pharmacology and public health, the other parts of the school being taken care of in the parts of the older building that had escaped total destruction and which were temporarily repaired for the purpose.

THE PRESENT ERA OF EXPANSION

The new building of 1911 was erected and opened under the able administration of Dr. F. J. Shepherd (1851-1920) professor of anatomy for the 30 years from 1883 on and dean of the faculty from 1908 to 1914 whose eminence both as a surgeon and educationalist were important



Fig. 6. The New Building of 1902, showing that of 1872 forming its first block, and behind this the extensions made in this and the previous year. The front and middle parts of this building were destroyed by fire in 1907.

factors in the advancement and growing reputation of the school, and were acknowledged by the conferring upon him of the honorary fellowships of the Royal College of Edinburgh and London and the honorary LL.D. of Harvard. This year 1911, marked also the commencement of what has been termed a golden age for McGill for in the 23 years that have elapsed since, an immense expansion has taken place largely in the direction of medical research, the first impetus to which may be said to have been given by the work of Wyntt Johnston (1860-1902) and Prof. J. G. Adams (1862-1926). During the last 15 years, that is, since the appointment as principal in the year 1920 of the late General Sir Arthur Currie with his fine spirit and splendid initiative force, and in 1923, as dean of the faculty, of Dr. C. F. Martin whose gift of organization and distinguished services to the cause of medical education were recently recognized by Harvard University by the conferring upon him of its honorary LL.D., this expansion has become nothing short of colossal. So swift indeed has this been alike in new departments organized, in generous benefactions received and in the appointment of men endowed with the spirit of enquiry and the faculty of leadership that a mere enumeration of these events is almost beyond the compass of this article. However, the contrast with the day of small things described above is so picturesque and the

outcome of the latter has been so spectacular that an outline must be attempted here.

Financial support was supplied in 1911, by the Robert Reford Endowment of \$100,000 for the department of anatomy and by the establishment of the Arthur A. Browne (\$10,000) and the James Douglas (\$35,000) research fellowships, in 1912 by the gift of \$14,000 for the establishment of the Eddie Morrice Laboratory of Pharmacology, in 1913, by the gift of \$12,566 subscribed by the friends and graduates of the medical faculty to meet the fire loss of 1907. In 1917 by the George Ross Endowment Fund, in 1919 by the bequest of Sir William Macdonald of \$500,000 to the funds of the faculty, a year marked also by the invaluable gift of the Osler library bequeathed to McGill on the death in that year of its beloved owner and founder. In 1921 came the great centenary celebration when \$6,000,000 was given to the University, of which \$4,000,000 was subscribed by the graduates and friends of the Institution, \$1,000,000 was given by the Province of Quebec, and \$1,000,000 was donated from the Rockefeller Foundation, the latter sum being a grant for the special uses of the medical faculty. In 1922 the Biological Building, erected on the site of the original medical building destroyed by fire, was opened housing the new department of biochemistry in which the researches of Prof. J. B. Collip and his associates have brought such



Fig. 7 The Strathcona Medical Building erected in 1912 and in occupation today. Contains the administration offices, medical and Osler libraries and museums and the departments of anatomy, histology and public health.

well deserved fame to the School in 1923 was built the fine Pathological Institute. In 1924, the University Clinic for Researches in Internal Medicine was established under the direction of Prof. J. C. Meakins, with the help of a grant from the Rockefeller Foundation of \$500,000. In 1925 came the erection of the Royal Victoria Montreal Maternity Hospital with accommodation for 200 patients and presenting the last word in equipment, under Prof. W. W. Chipman. A department of child study was instituted with the help of a grant of \$56,500 from the Laura Spelman Rockefeller Memorial Fund. In that year also the departments of public health and preventive medicine were united under the directorship of Prof. Grant Fleming, whose wide contacts with every health organization in the city as well as on the National Committee of Mental Hygiene, and as a member of the Advisory Health Board of the city make this a center of far reaching influence. In 1927 a subdepartment of industrial medicine with an industrial clinic at the Montreal General Hospital was established by a grant from the Metropolitan Life Insurance Company of \$25,000. In 1928 the department of bacteriology was recognized as a separate chair and has acquired in the person of Prof. E. G. D. Murray

of Cambridge an occupant of international fame. In 1929, a laboratory for experimental surgery was built and equipped by friends of the Faculty and \$85,000 was donated by the Rockefeller Foundation for surgical researches therein. During 1932-33 an additional \$100,000 was granted from the same source to maintain the research activities of the department of neuro-surgery.

Finally there has but now come to pass, as the crowning event of the benefactions listed above in the opening on September 27 last of the Montreal Neurological Institute under the direction of Profs. Wilder Penfield and W. V. Cone, what may well be described as the best and noblest achievement in the history of McGill's great Faculty. Just as, long ago in the stillness of the committee room of the old Montreal General Hospital, measures were promulgated and activities instituted by public spirited men of vision that gave birth to a great educational movement, so today the hour has once again struck, and opportunity has met, upon its crest, the men. Dr. Penfield was enticed to McGill in the year 1928, on the initiative of Dr. E. W. Archibald, professor of surgery, under the promise of financial support from a few public spirited citizens and the help of the research funds of the

faculty, and in company with his devoted associate Dr W V Cone. Immediately on arrival they organized an effective laboratory service within the necessarily restricted space available, and instituted an extremely active neurosurgical service with headquarters at the Royal Victoria Hospital, but having relations with practically all the hospital units in the city. The creation of the present magnificently equipped neurological Institute has been the result of incessant labor of all concerned in the 6 intervening years and was made possible by large endowments for its building and upkeep, which include a grant from the Rockefeller Foundation of \$1,232,650 and liberal yearly grants of \$15,000.00 from the City of Montreal and \$20,000.00 from the Province of Quebec as well as munificent gifts from several private donors—Sir Herbert Holt, Mr J W McConnell, Mr Walter Stewart, and four others who wish to remain anonymous. The Institute is thus a civic, national and international

affair, in affiliation with McGill but independent of it in funds, and functioning for the benefit of the community at large without restriction of place or creed. None who had the privilege of taking part in the great function of its inauguration, of listening to the first neuro-surgical foundation lecture by Dr Harvey Cushing and the addresses of Drs. Gordon Holmes, Martin Archibald, and others and Dr Penfield's own clear cut utterances on that occasion and who had surveyed the perfect adaptation of the building and its contents to the objects in view, can doubt that there is here developed on a sound and enduring basis an international center, in which the study and practice of clinical neurology and neurosurgery together with scientific investigation in these fields on the highest plane of inquiry, will combine to shed light over this entire continent and to introduce a new era in the understanding and treatment of these most obscure and potentially tragic of all human disorders.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE monograph on the lymphatics¹ by Drinker and Field, comprises 254 pages of well printed material, on pages 5 by 8 inches, bound in rigid covers. The authors state "The data presented is drawn from anatomy physiology pathology and immunology. We have wanted to give a working idea of what the lymphatics are steadily engaged in doing in the mammalian body. The first chapter of 12 pages is given to the structure of the lymphatic system and the next section discusses the entrance of foreign particles and colloidal solution into this system. The normal permeability of the blood capillaries and the balance of forces between the capillary blood and the tissue fluid is given considerable space. The authors state that the blood capillaries are the essential mechanism for determining the water content of the tissues. Lymphatic drainage, by keeping down the concentration of protein in the tissue fluid, affects water absorption but the actual instrument in accomplishing water balance is the blood capillary. The composition and flow of lymph are discussed. One of the principal interests of the authors was the problem of the relation of lymph to the fluid which actually bathes the tissue cells and in which the physiological reactions of the body occur. Capillary lymph and tissue fluid are considered to exist in a common reservoir and to this the blood capillaries make additions of fluid and withdraw it by reabsorption. Experimental and practical considerations comprise the second half of the book. An extensive bibliography and a nice review of the literature is given as the authors cover this subject in a scholarly and conservative manner.

M. H. BARBER

THE *Atlas of Pathological Anatomy*² compiled by E. K. Martin has been issued under the direction of the editorial committee of the *British Journal of Surgery*. This, the first volume, is made up of fasciculi published in the *British Journal of Surgery* during the years 1926 to 1930 inclusive and is the first of a series of such volumes which are intended to appear from time to time until it includes all such subjects as can profitably be illustrated by drawings of museum specimens, without attempting a reproduction of the rarities and curiosities of sur-

gical practice." The late Sir Anthony A. Bowlby in his introduction to the *Atlas* has emphasized the fact that illustrations cannot hope to replace the actual examination of specimens, but has expressed the hope that such illustrations will act as a stimulus and guide to the present day surgeon who too often relies entirely upon the opinion of a trained microscopist.

The arrangement of the material within the book is somewhat unusual in that it does not follow the various systems nor the classifications of general pathology. Thus, the book starts out with three sections dealing with bone tumors and ends up with a section on inflammation of bone, while between the first three and the last section are sixteen other sections dealing with the stomach, the breast, the kidney and the gall bladder and bile tracts. It is conceivable that if such a lack of arrangement obtains throughout the series, the surgeon who has to deal with an obscure bone lesion may have to scan through several volumes before he secures a comprehensive presentation of gross bone pathology. Even in this one volume the comparison of neoplastic with inflammatory bone disease requires turning from one end of the book to the other and still the whole of bone pathology amenable to illustration would not be covered.

The material presented is excellently illustrated, and especially pleasing are the numerous colored plates which are beautifully executed and reproduced. The specimens are carefully selected to show the more usual conditions with which the surgeon comes in contact and to depict those stages of the condition which are usually seen by the surgeon. Particularly excellent and especially valuable to the practicing surgeon is the section of 95 pages which deals with diseases of the breast. We find here page after page of illustrations of gross and microscopic appearances of benign and malignant conditions of the breast, accompanied by short clinical histories of each specimen.

Each section is headed by a short succinctly written introduction which covers, in a surprisingly thorough fashion, the important details of the pathological anatomy and histology. (MICHAEL L. MASON.)

ABOUT one-third of this volume³ of 400 pages by Pemberton and Osgood is devoted to the influence of the fundamental sciences on our knowledge

¹LYMPHATICS, LYMPH AND TISSUE FLUID. By Cecil K. Drinker, M.D., and Madeline E. Field, A.B. Ph.D. Baltimore: The Williams & Wilkins Co. 1931.

²ATLAS OF PATHOLOGICAL ANATOMY. Issued under the direction of the Editorial Committee of the *British Journal of Surgery*. Compiled by E. K. Martin, M.B. F.R.C.S. vol. Baltimore: William Wood & Company 1931.

³THE MEDICAL AND ORTHOPAEDIC MANAGEMENT OF CHRONIC ARTHRITIS. By Ralph Pemberton, M.S., M.D. F.A.C.P., and Robert B. Osgood, A.B. M.D. F.A.C.P. New York: The Macmillan Co. 1934.

of joint disease. The etiological factors, local and general, are discussed at length and the symptomatology and treatment are presented admirably. The work is divided into 14 chapters, with a bibliography appended at the end of each chapter. This makes it valuable as a reference, for the outstanding work in the world literature of joint disease is included.

In the preface, the authors condemn the unjustifiable pessimism toward arthritis which is extant in many quarters of the medical world today. They believe that such an attitude has been an important factor in delaying the advent of adequate therapy in this field. Certainly this is true, as those of us who see a great deal of arthritis know, and the physician who with a shake of the head, allows a patient with this disease to progress to the state of an arthritic derelict assumes an enormous responsibility.

To me the most interesting and instructive part of the book is that devoted to the fundamental sciences. The newer aspects of normal and abnormal joint physiology are well presented, and the text and illustrations of joint pathology are in every sense adequate. For better illustrations from the standpoint of detail one may look to the similar work of Allison and Ghormley (William Wood & Company).

The treatment of arthritis, as the title of the book implies, is considered under the heads of medical and orthopedic management. None of the methods advocated is essentially new, but the comprehensiveness with which the authors present this phase of the subject makes the work a valuable adjunct to the practitioner's library. The subject of the theory and practice of drugs, vaccines, and physical therapy is included as well as of conservative and operative orthopedic treatment.

While the authors intend this book principally for practitioners, I think it desirable for the use of students in their clinical years. With their courses of pathology and physiology just completed this book, with its specialized point of view, should give them a valuable insight into the nature of arthritis. The treatment as outlined, and the associated references, should enable them to appreciate the possibilities of helping arthritis, which is in the larger sense the purpose of this book.

PAUL B. MAGNUSON

THE conception of the fundamental radiological principles on which the diagnosis of various gastro-intestinal lesions must be based is described and analyzed by the Cole collaborators in their recent work.¹ The anatomical, pathological and roentgenological findings are correlated. The book was not intended to be a text on gastro-intestinal X-ray diagnosis. Dr. Cole's originality and resourcefulness is amply displayed not only in the device of apparatus for carrying out his original technical

ideas, but also in his ingenious adaptations of line drawings and photographs and the interpretation of roentgenograms. The authors have advanced a number of original theories and interpretations, some of which are at variance with the ideas of well known physiologists and some of the previously published work from abroad but indeed Dr. Cole makes no positive claim to be correct, simply leaving the reader to draw his own conclusions. The pages of this work represent an enormous amount of labor unselfishly devoted to the elucidation of some important gastro-intestinal problems. Its chief value lies in this praiseworthy attempt to open up to more general recognition the radiological interpretation of findings in the small intestine.

With reference to the technique, attention is drawn to the emphasis, laid especially in Europe upon relief studies of the digestive tube. Much stress has been laid upon localized pressure applied with a compression bag or similar means. The authors make the significant statement that they have yet to see a single case in which localized pressure has established the diagnosis of any ulcer of the duodenum or any other organic lesion of the stomach where the diagnosis has not already been established by the serial routine method of examination in common use in this country.

In systematizing the interpretation of gastro-intestinal screen and film findings, studies were directed to the following 4 fundamental findings which Cole advances as the criteria for exploring the mucosa of the digestive tract: (1) the lumen of the tract viewed in profile, (2) special folds of the mucosa viewed on edge, (3) pliability of the mucosa to peristaltic contraction (4) the pattern of the mucosal folds or rugae.

JAMES T. CASE

ANOTHER of the series from the Oxford University Press on medical disorders is presented by Platt in a volume of 166 pages,² in which he discusses nephritis and allied diseases. The author states that the book is not intended as a first introduction to the physiology or pathology of the kidney but rather for the senior student or practitioner who is, of course, assumed to have a certain familiarity with the clinical conditions of oedema, high blood pressure, albuminuria and the like, and to have seen cases of nephritis in the hospital wards or in practice.

The theory of filtration and differential absorption has so much evidence to support it that it may be accepted provisionally as correct, especially since the researches of Richards and Wearn. Chapters I and II however are given to a simple discussion of structure and function of the kidney together with functions in disease. Chapter III deals with a discussion of urine examination and renal function tests. A very simple practical explanation for the author's classification of renal disease follows.

Nephritis and nephrosis are used in a broad sense

¹RADILOGICAL EXPLORATION OF THE MUCOSA OF THE GASTRO-INTESTINAL TRACT. By the Cole Collaborators. Lewis Gregory Cole, M.D., Robert E. Pezard, M.D., William Gregory Cole, M.D., Russell R. Moore, M.D., Courtney I. Hendland, M.D., Ames William Nordwood, M.D. St. Paul and Minneapolis. The Bruce Publishing Co. 1934.

²NEPHRITIS AND ALLIED DISEASES, THEIR PATHOGENESIS AND TREATMENT. By Robert Platt, M.D. (Sheff.) M.R.C.P. (Lond.) London: Oxford University Press, 1934.

as denoting the more inflammatory and the more degenerative forms of Bright's disease, respectively and as degenerative changes are always present in nephritis, there is no valid objection to looking upon nephrosis as a sub-variety of nephritis, the term denoting not cases showing tubular degeneration but rather cases in which inflammatory changes are inconspicuous." It seems to the author wrong to make too sharp a distinction between lipid nephrosis and subacute nephritis since both commonly arise in connection with some septic process in the body. Nephrosis may therefore, be looked upon as a variety of subacute nephritis in which some of the

signs are minimal or lacking. The arterial and sclerotic cases are placed in a group called nephrosclerosis. A small section is given to renal dwarfism and polycystic kidneys. The sections on treatment are concise and they are stated in a practical manner.

This treatise on the whole seems to be a good discussion of medical diseases of the kidney. A broad, constructive viewpoint obtains which gives the feeling that the author has had a substantial experience in the field of renal disease. The sections on treatment are up to date and practical. This little volume should be of assistance both to the student and the practitioner.

M HERBERT BARKER

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

OPTICOMELTIS: ITS PATHOGENESIS, SYMPTOMATOLOGY AND TREATMENT. By Abraham O. Wilensky, A.B. M.D. F.A.C.S. New York: The Macmillan Co. 1934.

THE B.C.G. VACCINE. By K. Neville Irvine, D.M., M.A. B.Ch. (Oxon.) F.R.C.S. L.R.C.P. London: Oxford University Press, 1934.

GYNECOLOGY. By Brooke M. Ansbach, M.D. 5th ed. Completely revised with the assistance of Philip F. Williams, M.D. and Lewis C. Scheffer, M.D. Philadelphia, London, and Montreal: J.B. Lippincott Co. 1934.

LA TROMBOANGIITIS OBLITERANTE. By Dr. Julio Dies. Buenos Aires, 1934.

CLINICAL PAEDIOLOGY OF THE JAW, WITH A HISTOLOGIC AND ROENTGEN STUDY OF PRACTICAL CASES. By Kurt H. Thoms, D.M.D. Springfield, Ill. and Baltimore, Md. Charles C. Thomas, 1934.

ENDOGENE FAKTOREN IN DER TUMORGENESE UND DER HEUTIGE STAND DER VERSUCHE EINER MOLOGISCHEN THERAPIE. By Professor Dr. G. Fischer. Berlin: Julius Springer, 1934.

PRACTICAL SURGERY OF THE ABDOMINAL AND PELVIC REGION. By James William Kennedy, M.D., F.A.C.S. 3rd ed. Philadelphia: F.A. Davis Co. 1934.

THE AUTONOMIC DISEASES OR THE RHEUMATIC SYNDROME. By T. M. Rivers, M.D. Philadelphia: Dorland & Co. Inc. 1934.

THE PHYSICAL AND MENTAL GROWTH OF PREMATURELY BORN CHILDREN. By Julius H. Hiss, M.D. George J. Moser, M.D. and Phyllis F. Bartelme, Ph.D. Chicago: The University of Chicago Press, 1934.

DISEASES OF WOMEN. By ten teachers. Under the direction of Conyns Berkeley, M.A. M.D., M.C. (Cantab.) F.R.C.P. (Lond.) F.R.C.S. (Eng.) M.M.S.A. (Hon.) F.C.O.G. Edited by Conyns Berkeley, J.S. Fairbairn, Clifford White. 5th ed. Baltimore: Williams Wood and Co. 1934.

AIDS TO OPERATIVE SURGERY. By Cecil P. G. Wakeley, D.Sc. (Lond.) F.R.C.S. (Eng.), F.R.S. (Edin.) 3rd ed. Baltimore: William Wood & Co. 1934.

BENIGN, ENCAPSULATED TUMORS IN THE LATERAL VENTRICLES OF THE BRAIN, DIAGNOSIS AND TREATMENT. By Walter E. Dandy, M.D. Baltimore: The Williams & Wilkins Co., 1934.

AIDS TO OBSTETRICS. By Leslie Williams, M.D. M.S. (Lond.) F.R.C.S. (Eng.) M.C.O.G. 10th ed. Baltimore: William Wood & Co. 1934.

REYERSON ANATOMIA DEL SISTEMA ARTERIAL. Vol. 1d, 2nd part—Atlas Estereoscópico de Anatomía de las Arterias. By Pedro Belon. Buenos Aires, 1934.

PERIODIC FERTILITY AND STERILITY IN WOMEN. etc. By Professor Hermann Korus. Authorized English translation by D. H. Kitchin and Kathleen Kitchin, M.Sc. M.B. B.S. Vienna: Wilhelm Mandrich, 1934.

CHIRURGIA DEL CANCRO. By Prof. G. Fischer. Milan: Urico Hoepli, 1935.

THE NEW BORN BABY: A MANUAL FOR THE USE OF MIDWIVES AND MATERNITY NURSES. By Eric Pritchard, M.A. M.D. (Oxon.) F.R.C.P. (Lond.) London: Henry Kimpton, 1934.

SURGICAL APPLIED ANATOMY. By Sir Frederick Treves, Bart. 9th ed., revised by C. C. Choyce, C.M.G. C.B.E. B.Sc. N.Z., M.D. (Edin.) F.R.C.S. (Eng.) Philadelphia: Lea & Febiger, 1934.

SYSTEM OF DICTE WRITING. By William S. Collins, B.S. M.D. New York: Form Publishing Co. 1934.

OUR HERITAGE AND OTHER ADDRESSES. By Colonel the Hon. Herbert A. Bruce, R.A.M.C. M.D. L.R.C.P., F.R.C.S. (Eng.) L.L.D. Toronto: The Macmillan Co. of Canada, Ltd. 1934.

THE 1934 YEAR BOOK OF RADIOLOGY, DIAGNOSIS. Edited by Charles A. Waters, M.D. THERAPEUTICS. Edited by Ira I. Kaplan, B.Sc. M.D. Chicago: The Year Book Publishers, Inc. 1934.

TREATMENT BY DIET. By Clifford J. Barborka, B.S. M.S. M.D. D.Sc. F.A.C.P. Philadelphia, London, Montreal: J.B. Lippincott Co. 1934.

BODY MECHANICS IN THE STUDY AND TREATMENT OF DISEASE. By Joel E. Goldthwait, M.D. L.L.D. Lloyd T. Brown, M.D., Irving T. Swann, M.D., and John G. Kainer, M.D. Philadelphia, London: J.B. Lippincott Co. 1934.

TRANSACTIONS OF THE AMERICAN SURGICAL ASSOCIATION. Vol. 52. Edited by Walter Estell Lee, M.D. Philadelphia: J.B. Lippincott Co. 1934.



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PRINCIPLES OF GASTRIC SURGERY¹

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THE American College of Surgeons in this annual lecture keeps before its Fellows the life and work of John B. Murphy. Previous lecturers from this country and abroad have rendered tribute to those extraordinary talents through which Murphy attained great eminence and have discussed the contributions through which this master surgeon was such an important factor in elevating American surgery to the position which it has attained. It is therefore at once an honor and a responsibility to join in the commemoration of a founder of the College who created for himself a permanent place in the history of surgery and of surgeons.

The evaluation of Murphy's writings arouses amazement for it seems inconceivable that with facilities which the surgeon of today would consider meager and inadequate Murphy could have made so many classic contributions which time has confirmed. The surgical treatment of pulmonary tuberculosis of trigeminal neuralgia, of lesions of bones and joints of genito-urinary disorders and of intra-abdominal conditions, particularly acute appendicitis, tuberculosis of the fallopian tubes, and lesions of the gastro-intestinal tract are a few illustrations of the wide interests of his inquiring mind and of the range of his accomplishments.

The progress of surgery since the time of Murphy has been, and will continue to be in specialization and it is doubtful if any sur-

geon of the future ever will equal him in the originality of the investigations which he made in so many different fields. He possessed that uncommon quality of maintaining both an intensive interest in a subject and a determination to know the truth until by persistence and rare clinical experience and judgment he effected its highest possible development. Putti referred to Murphy as "perhaps the last of a generation of general surgeons who are able to cope with the whole field of medical practice in all its complexities and who have laid the foundation of modern specialization." With his ability to solve the intricate surgical problems of his day, he acquired the art of imparting his knowledge to others in a superlative degree and became recognized by surgeons of all countries as the greatest teacher of surgery of his time. To those who had the privilege of attending his clinics the name of Murphy will always be an inspiration and the American College of Surgeons, through this memorial lectureship, will carry on to coming generations the influence derived from a contemplation of the life of this master surgeon.

Inasmuch as not the least notable of the contributions of Murphy are to be found in his published works on diseases of the stomach and duodenum, a brief consideration of the evolution of the principles underlying gastric surgery would seem appropriate to this occasion.

¹The John B. Murphy Oration on Surgery presented before the Clinical Congress of the American College of Surgeons, Boston, October 5, 1934.

One of the fathers of modern surgery was Theodor Billroth of Vienna. His clinic, like Murphy's, became a Mecca for students of his day and much of the impetus to American surgery can be attributed to Billroth and his school. He was the first to resect the stomach successfully. As Wiess wrote, "There was nothing accidental in its success. Months of hard, persistent study preceded the attempt, the pathology of gastric carcinoma was thoroughly reviewed, statistics were scrutinized from every angle and an entirely new technique had to be devised and practiced. It is interesting to note, as Finney pointed out in a review of the history of gastric surgery that the great surgeon Langenbeck, only a few years before Billroth performed a resection of the stomach, had said "I look upon this operation as a quicker method of sending out of this world a man whom it is impossible to save. Contrast this with Billroth's prediction that every surgeon who has had experience in experiments on animals and similar operations in men has reached the conviction that resection of the stomach must and will succeed. Finney rightly emphasized the part of experimentation on animals in this development since it was the practice of these pioneer surgeons carefully to plan carry out, and study the results of operations on animals before employing them on men. Billroth was a pioneer in surgical pathology and made many contributions in this field, but his greatest legacy was his pupils, who were called to fill many of the chairs of surgery not only in Austria, but also in Germany. Murphy always gratefully acknowledged that his methods of clinical investigation were based on what he had observed in Billroth's clinic, and that he owed much of his knowledge of clinical teaching to Professor Albert of Vienna, a contemporary of Billroth.

To the influence of Billroth and his pupils, therefore, may be attributed the progress of gastric surgery and the rapidity of this progress is extraordinary in view of the status of abdominal surgery before this period. The development was characterized by the evolution of technical methods, to the end that operations for lesions of the stomach and duodenum could be safely performed. In this

evolution American surgeons have had a large part. General principles of management soon became established, and various technical procedures were developed to deal effectively with the variabilities of benign and malignant lesions. Attention was directed primarily toward security of suture lines and to this end attempts were made to eliminate the "fatal suture angle" of the original Billroth I resection (end to-end, stomach to duodenum) and to prevent mechanical complications. The problems involved in accomplishing these purposes are evidenced in the many modifications of operations on the outlet of the stomach, of reconstruction operations for gastric resection, and of gastro-enterostomy. The history of gastro-enterostomy is a conspicuous example of the development of gastric surgery during this early period for the causes of the mechanical defects, which at first almost prohibited performance of the operation became known, and the operation was so modified that now such complications are rarely encountered when the indications for the operation are clear and it is properly performed.

The menace of anastomosis by suture, however still retarded the advance of gastro-intestinal surgery and a variety of mechanical devices, such as bone plates, were advocated to cope with this danger. None, however proved satisfactory until Murphy in 1892 announced the invention of a metal button for accomplishing quick and secure anastomosis between segments of the gastro-intestinal tract. This instrument became known as the Murphy button and the evidence soon was conclusive that in respect to safety it was superior to the suture as then employed. This offered a challenge to those who were striving to perfect methods of suture, for the disadvantages of the introduction of a non-absorbable foreign body were obvious if some procedure equally safe and not requiring the use of non-absorbable material could be devised. The place of the Murphy button in the evolution of gastro-intestinal surgery especially in those portions of the intestinal tract in which infection is a particular menace, is manifested in the methods still being devised to what Murphy accomplished with the button namely aseptic anastomosis.

The primary impetus to gastric surgery, therefore, was the perfecting of technique to a point at which operation could be carried out with minimal risk. The secondary, but no less important, impetus came from the spectacular results following the surgical management of lesions of the stomach and duodenum and of their complications. The revelation that surgical intervention usually could accomplish permanent cure of such a chronic disease as gastric or duodenal ulcer, could cure a definite percentage of cancers of the stomach, could save the life of the patient with an acute perforation and could permanently relieve benign obstructions, marked one of the great advances of modern medicine.

The success with which surgery met such conditions led naturally to efforts to employ surgical treatment in the earlier stages of disease. In the case of carcinoma of the stomach, such efforts were well founded and have definitely increased the operability of the disease. In the case of ulcer however, the apparent desirability of earlier surgical management unfortunately led not only to operation being carried out for lesions not suitable for such treatment, but not infrequently even led to operation on the stomach before a lesion existed. The practice of earlier operation however, had far reaching effects, particularly because actual facts were disclosed, resulting in more exact clinical diagnosis and a better correlation of pathology and symptoms. From a surgical standpoint, the most important result of such practice was to establish a point which I believe is not yet fully appreciated that while the effectiveness of surgical treatment of gastric cancer increases with the earlier recognition of the disease the reverse is true of the benign ulcerations of the stomach and duodenum.

The demonstration at operation of lesions of the stomach and duodenum, and the failures and successes following their surgical management, brought about a vast acquisition of knowledge related to the physiology of digestion in health and disease, of the pathological features of lesions in their various stages, of the variabilities of their clinical manifestations, and of the incidence and nature of complications. Such advances have

resulted in large part from roentgenology, for the film and screen will determine, in 95 per cent of the cases whether or not a lesion is present, will identify the situation and probably the pathological characteristics of a lesion which is present, will disclose the effects of the lesion on gastric motility, and will give most useful information as to the extent and direction of malignant invasion. Such visualization gives to the clinician opportunities impossible before such methods of examination were developed. It enables him to distinguish more accurately between the functional and organic forms of dyspepsia, and it makes possible that correlation of facts on which the structure of the therapeutics of lesions of the stomach and duodenum must be built.

Surgery of the stomach and duodenum at present, therefore, is based on a foundation of physiological knowledge that has been greatly advanced through experimental and clinical observations, exact pathological classification of lesions, accuracy of diagnosis better understanding of the indications for operation, more intelligent application of operative procedures, and established principles of technique. As a result, the surgical treatment of lesions of the stomach and duodenum now can be viewed in a broader aspect than ever before.

The urgency of establishing the safety of operation has been reflected in the gradual decrease in mortality and morbidity following operations for lesions of the stomach and duodenum, and large series of cases have been reported from various clinics of the world, in which the mortality of conservative operations for duodenal ulcer is 1 per cent or less, of gastric resection for gastric ulcer 3 or 4 per cent or less, and of resection for gastric cancer less than 10 per cent in general and less than 5 per cent in early cases. Although some of these series may be rightly considered record performances and difficult of duplication, yet they are evidence of the advances which have been made in the safety of operative procedures when there has been intelligent selection of cases and of operation, adequate preparation of the patient, and the surgeon has the required judgment, skill, and experience.

Such examples of the safety of operation on the stomach and duodenum, in respect to both mortality and morbidity should not give the impression that grave menaces are not always present in such operations. Although it is true that perfected technique has largely eliminated the dangers of serious complications directly attributable to the operations themselves, such as hemorrhage or mechanical defects in the line of suture, other postoperative sequelae equally serious, may develop. By far the most important of these are postoperative pulmonary complications, which, in spite of definite progress in their prevention continue to occur about twice as frequently as they do after operations in the lower part of the abdomen. It is true that although the low mortality of operations on the stomach and duodenum belies the seriousness of pulmonary complications, study will show that at least 50 per cent of the deaths are attributable to them. Since the incidence of these complications is apparently the same whether or not the patient has been anesthetized by inhalation the primary or major factor contributing to their occurrence is often a mechanical one such as diaphragmatic spasm or unexpelled bronchial secretions. The latter are now considered as the probable precursors of the most common pulmonary complications, namely bronchopneumonia and atelectasis, and the further reduction of the incidence of these complications will depend on the efficacy of methods to prevent accumulation and retention of bronchial secretions.

Now that safety of gastric surgery has reached a point from which it will be difficult to make further advances, the question of the efficacy of surgery in the cure or treatment of lesions of the stomach and duodenum becomes paramount for as W. J. Mayo pointed out the time has long since passed when the mere survival of the patient following operation for chronic disease measured the success of the operation. The relative merits of operations, as measured by ultimate results, never can be dissociated from their risk; therefore the basis on which further development will rest must take into account both the risk of operation and the possibilities of cure or palliation. It is from this standpoint that the

present status of surgery for the common lesions of the stomach and duodenum namely cancer and ulcer may be briefly discussed.

The surgical treatment of cancer of the stomach in respect to both cure and palliation should be judged not only as to the actual results of such treatment but also in relation to other methods of management of which there is none. Pessimism may be so extreme that the fact that recurrence of the disease can be prevented in a definite percentage of cases, following removal of the growth is disregarded and the fact is forgotten that nothing other than surgery offers any possibility of complete or permanent relief. Since the only prospect of cure at present lies in extirpation of the growth the problem of management becomes one of recognition of the disease at a time when such treatment can be carried out. It is not to the credit of the medical profession that in only 1 out of 4 cases of cancer of the stomach, when first encountered by the surgeon, can even an attempt be made to cure the patient. At the same time it would be unwise to underestimate the difficulties of early recognition for it is unfortunately true that the majority of cancers of the stomach give rise to slight or even no symptoms in their early stages. It is also true however that in the study of any series of cases in which resection is carried out the average length of time that the patient has been conscious of symptoms has been 11 months. It would seem therefore that in this lies a challenge to members of the medical profession to convince the public that slight deviations from normal are worth meticulous clinical investigation, and to convince themselves that this investigation should include the only method by which early diagnosis of cancer of the stomach can be made, namely competent roentgenological examination.

Assuming that the diagnosis has been made sufficiently early the basis of management of cancer of the stomach is the surgical exploration of all malignant lesions which are apparently confined to the stomach, have not given rise to distant metastasis, and do not encroach on or involve the cardiac orifice.

The most effective treatment both in respect to maintaining low mortality and low

morbidity, and increasing curability, depends on the following factors: first pre-operative overcoming of the effects of dehydration, second, pre-operative cleansing of the stomach by lavage, third, anesthesia adequate to allow satisfactory examination of the growth and possible detection of metastasis, fourth wide removal of the growth and of a segment of the first portion of the duodenum together with as nearly complete as possible extirpation of lymph nodes, and last, such restoration of gastro-intestinal continuity that the anastomosis not only will function well, but in the event of recurrence of the disease most likely will ensure protection against obstruction of the gastro-intestinal tract.

The results of such management have shown that in various consecutive series of cases studied, in which resection has been performed for gastric cancer, the mortality can be 10 per cent or less. The patients alive and apparently well 3 years after operation average 52 per cent in those cases in which the disease was confined to the stomach and 19 per cent in those cases in which lymph nodes were involved. In the cases in which resection was performed with or without lymphatic involvement, 19 per cent of the patients are alive and apparently well at the end of 5 years.

Palliation in gastric cancer is an important function of surgical treatment. Removal of the growth has proved to be the most satisfactory procedure, because definite prolongation of life and protection against distressing symptoms frequently is accomplished. An excellent substitute for removal is complete exclusion by division of the stomach above the growth, closure of the distal segment, and uniting of the jejunum to the proximal segment of the stomach, by the method of Devine, of Melbourne. Gastro-enterostomy is usually of little benefit, and should marked or prolonged improvement follow this operation, it would constitute evidence that the growth probably could have been removed. In non-surgical management of inoperable lesions with obstruction, the value of the stomach tube as pointed out by Kussmaul in 1869, should not be forgotten. It was the practice of W. W. Mayo for many years to instruct patients in the use of the stomach tube

With this and a liquid diet of fruit juices, rice water, and so forth, he brought about much amelioration of symptoms. Radiation has been disappointing for any palliative effect.

Cancer is the most fatal organic disease of the stomach, but gastric and duodenal ulcer are the most frequent diseases. The chief problem concerning ulcers, which still awaits solution, concerns their cause. Although much contributory evidence has come from clinical and experimental investigation in relation to disturbed function, particularly secretory and motor function, and in relation to infection and to neurogenic factors, evaluation of these continues to be difficult. A lesser problem concerns the indications for and the merits of, the various operations for gastric and duodenal ulcer. Since, with the realization that it was both impractical and incorrect to attempt to classify gastric or duodenal ulcer as either a medical or a surgical disease, great progress in management came when physician, roentgenologist, and surgeon co-ordinated their opinions, viewpoints and advice. Perhaps the greatest impetus to such co-ordination can be attributed to roentgenology, which attained such perfection as to remove almost all uncertainty in determining the presence of gastric and duodenal lesions. Nevertheless, from a diagnostic standpoint there is still the pre-operative problem of determining the exact pathological character of the ulcer of the stomach. One of the most valuable advances which could be made would be some method of determining with certainty whether or not such an ulcer were malignant. It is true that the experienced clinician and roentgenologist together, by evaluating every possible sign and symptom, can be reasonably certain of the pathological character of a lesion of the stomach, but there is as yet no absolute evidence other than that which can be secured by microscopic study of the lesion after removal. Should some method become available to distinguish clinically these lesions, one from another, then ulcer of the stomach could be treated medically without the ever present fear and humiliation of attempting to cure a malignant lesion by diet and alkalis. That a gastric ulcer, primarily benign, may become malignant, is recognized

by all clinicians, roentgenologists, and pathologists the only difference of opinion is related to the frequency of this complication.

The success of the surgical treatment of both gastric and duodenal ulcer depends largely on selection of those cases for operation in which good results can be expected. This skill in selection is particularly necessary in duodenal ulcer in which variability of symptoms is much greater than in gastric ulcer. The indications for surgical treatment of gastric ulcer are relatively simple for it is a basic rule that if the ulcer fails to heal, it should be classed as a lesion other than ulcer. Even though symptoms are more or less quiescent well planned and well performed surgical operation is safer for the patient than harboring a lesion which persists. In duodenal ulcer the general indications for operations are clear when the symptoms become chronic and sufficiently severe and when such complications as impaired motility repeated hemorrhage or acute or chronic perforation have occurred. The mere presence of a duodenal ulcer is by no means a justification for operation.

The general principles of surgical management begin with the premise that the most efficient surgical treatment of gastric and duodenal ulcer is that which will accomplish the best control of the disease with the least possible risk. Consequently in ulcer the surgeon must be familiar not only with the indications for operation but also with the details of the technique of the variety of procedures in order to deal with the lesions in their various situations.

In so far as gastric ulcer is concerned, accuracy of diagnosis has made possible its recognition much earlier than formerly so that in the majority of cases the lesion is still small when operation is carried out. Furthermore, in 90 per cent of the cases the lesion is sufficiently near the angle of the stomach so that its accessibility is not a problem, and any gastritis associated with the lesion is not extensive. Such lesions lend themselves so satisfactorily to local excision, combined with gastro-enterostomy that partial gastrectomy usually seems unnecessary. The results of a well performed excision either with cautery or knife, combined with gastro-enterostomy

will equal the results of partial gastrectomy in so far as relief of symptoms is concerned moreover it has long been known that the danger of jejunal ulcer when gastro-enterostomy is done for a lesion of the stomach, is practically negligible. It is true however that from a technical standpoint alone local excision of a large lesion, combined with gastro-enterostomy may be a more formidable procedure than gastric resection. In the high-lying large lesions, even radical operation may be unwise, for not only does the sacrifice of healthy stomach seem unreasonable but re-establishing gastro-intestinal continuity is fraught with much added danger. In such cases when the lesion is so situated that direct attack on the ulcer is not advisable healing can be brought about in a certain percentage of the cases by either gastro-enterostomy or jejunostomy.

In the treatment of duodenal ulcer there is much discussion as to the relative merits of operations, but it should be realized that no surgeon regardless of what operation he may favor applies it in all cases. It is true also that the greater the experience of the surgeon, the more skilled he is in selecting the procedure which will best meet the requirements in each case. The indications for the various procedures, therefore, present a very complicated question, since the age, sex, physical condition, and even the personality of the patient, as well as the variability of the lesion the known physiological effect of the operation, and the skill of the surgeon must all be taken into consideration. The basis on which the most common operations for duodenal ulcer are carried out can be briefly formulated. The more chronic the lesion and the more motility has been impaired the clearer is the indication for gastro-enterostomy. On the other hand as Ryle pointed out, no attempt should be made to circumvent mechanically a lesion which is producing no considerable mechanical disturbance of function. Again the older the patient (which usually implies relatively lower gastric acidity) the more clearly is gastro-enterostomy the operation of choice. The contra indications to gastro-enterostomy are the indications for those procedures which include removal of the lesion of the duodenum

and reconstruction of the outlet of the stomach. The many variations in such direct methods are designed for these purposes, first, to remove as thoroughly as possible the lesion or lesions of the duodenum, second to provide a satisfactory outlet for the stomach. Partial gastrectomy for duodenal ulcer should, I believe be reserved for those patients who have had such serious bleeding that thorough removal of the first segment of the duodenum is distinctly to their advantage, and for those patients who are suspected of suffering from a high liability to recurrent ulcer. The most important of all the indications for gastric resection for duodenal ulcer should be that the operation can be done with little more risk than a conservative procedure. It should be remembered, in this connection that no operation can entirely insure the patient permanently against recurrence.

When surgical treatment is carried out on the basis outlined the results will show that in cases of chronic duodenal ulcer in which surgery is clearly indicated, approximately 90 per cent of the patients can be given complete and permanent relief of symptoms and protection against recurrence of the disease. This is a great accomplishment in a disease which has as chronic characteristics as has duodenal ulcer. In a recent article Walton in reviewing his experience in more than 1800 operations for chronic ulcer emphasized the excellent results which can be obtained in duodenal ulcer by use of conservative procedures, one of the most important reasons why such results can be reported is that not only was skill employed in determining the indications for

surgery but also good judgment was used in selection of the operation.

Gastric and duodenal surgery is not static, and to be progressive surgeons must persistently adjust themselves to the clinical variabilities of the diseases of the stomach and duodenum to changing viewpoints as to causes of such lesions to the difficulties of instituting surgical intervention at the optimal time to new or revised methods of treatment, both surgical and medical, to shifting concepts of physiology particularly as it applies to restoration of function following various operations and to the inherent technical problems. The stomach and the first portion of the duodenum are particularly vulnerable to those conditions which may be precursors of chronic disease. One reason for this is that the stomach and first portion of the duodenum which are derived from the foregut are of later development in embryonic life than is the remainder of the small intestine and the colon and consequently have not acquired maximal immunity. Another reason is that the stomach, since it is insensitive to irritants which in other parts of the body would arouse painful stimuli is subjected to injury and abuse. This may explain the frequency of lesions of the stomach and duodenum particularly the frequency of cancer among men. It is such problems as these that have made the developments in the surgery of such a complex field one of the epochs of medical history, and further advances in the surgical treatment of diseases of the stomach and duodenum will always demand adherence to the same precepts and practices as characterized so notably the life of John B. Murphy.

INFECTION IN CLEAN OPERATIVE WOUNDS

A NINE YEAR STUDY¹

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MANY of the details of the sterile technique of surgical operating rooms have been passed on to us by hospital tradition or by word of mouth from our immediate predecessors on the staff. Most of these details we have taken for granted without questioning their rationale. We assume that at some time in the past the reason for this or that step in our procedure was adequately demonstrated. Certain methods are common to all good hospitals. Others have been instituted locally but are not used elsewhere. It is only on such occasions as this when surgeons gather together to discuss their problems and to see how the other fellow does it, that we find certain steps in the sterile technique which are different from our own. Then if we are interested we question our hosts, or our confreres or ourselves, in an effort to determine which methods are better theirs or ours. When we ask for proof that a certain step is better we often find that the other fellow has always done it that way but doesn't know why. Consequently we do not make this change in our own technique. Or worthy changes appear too costly in time or money to warrant their adoption. Often we wait for a catastrophe such as a fatality or a series of deaths or an epidemic in our own hospital to call us to account for our methods. Such an event may disturb our equanimity for a short time and then be forgotten or it may irritate us to the point of making certain changes, or it may stimulate us to re-survey the whole problem and rationalize the whole procedure, weeding out useless steps and adding methods of proved worth in order to bar the way to a future occurrence of the same tragedy. But so often the experience of one individual or one group cannot be passed on to another individual or group. One may be able to profit by his own mistakes but not by those of others or learn from others' experiences.

I must confess that we were going blissfully on our way using operating room technique

handed down for several decades in the firm conviction that it could not be improved upon and that we were getting excellent results in our wound healing. One day on staff rounds in the spring of 1925 a clean case was found to have a wound infection. The matter came up for general discussion and the chief of one of the surgical services was asked what percentage of clean wounds he thought became infected. He was an individual extremely careful to be honest and straightforward in his statements. He replied that he thought, if every minor infection were counted, the total might possibly reach 2 per cent. I stated my impression that we were then having more infections than usual and that they might then be in the neighborhood of 5 per cent. I was thereupon assigned the task of finding out what the actual figures were. The records were reviewed from the beginning of 1925. All of the clean cases were listed together with all of the circumstances of the operation. The dressing notes were scrutinized and any evidence of infection during the process of wound healing was noted.

It soon became evident that not 2 per cent or 5 per cent but about 15 per cent of our clean wounds were becoming infected and that a large number of the serious infections were due to the hemolytic streptococcus. The actual figures were seven and a half times as great as had been suspected by an honest observer. This fact is emphasized because I am sure that impressions are woefully inaccurate in most instances and when you hear any one say that the wound infections in his hospital are negligible, the statement should be discounted unless there is an actual count and a careful study of the dressing notes. Operators who permit the internes to remove the stitches from their wounds may never know how many of the cases become infected. They have a false sense of security and yet they may conscientiously say that they seldom, if ever see a clean wound become infected.

From the Surgical Service of the Presbyterian Hospital and the Bacteriologic Research Laboratory of the Department of Surgery, College of Physicians & Surgeons, Columbia University. Presented at the symposium on the "Treatment of Infections" before the Clinical Congress of the American College of Surgeons, Boston, October 17-20, 1924.

Some years ago Brewer shocked the attending staff of a New York hospital when he studied wound infection and found that 30 per cent of the clean cases became infected. By rigid attention to the possible sources of infection this figure was immediately reduced in his hospital.

When we found to our dismay that many of our clean wounds were developing infection we decided to try to discover where the organisms came from and how they gained a foothold in the tissues.

THE SOURCE OF THE INFECTING ORGANISMS

The organisms which were cultured from the wounds gave a clue to the sources of contamination. Yellow and white staphylococci were found in the majority of cases. A much smaller number yielded hemolytic streptococci or non hemolytic streptococci. More rarely *Bacillus coli*, *Bacillus subtilis*, *Bacillus pyocyaneus*, *Bacillus proteus* and diphtheroids were found. The variety of the organisms suggested that the source of these organisms might be various. Every step of the sterile technique was carefully scrutinized to determine if possible, where the bacteria came from. It was thought, first of all, that they might come from the materials entering the wound for example, the gauze sponges supposedly sterilized by autoclaving (Two years ago Dandy maintained that almost every wound infection resulted from contamination from this source and stated that in his institution infections had completely disappeared following the prolongation of the sterilizing process.) Or it was thought that the germs might come from the instruments supposedly sterilized by boiling, or the knife blades and sharp instruments supposedly sterilized by soaking in alcohol, or from the catgut supposedly sterilized by heating or from the water or saline used during the operation supposedly sterilized in large tanks. Second it was thought that they might come from the dust particles in the air which dropped upon the sterile field during the course of the operation. Third they might come from the skin of the patient supposedly sterilized by the skin antiseptic, or from the deep tissues or from the blood of the patient. Fourth, they might come from the nose or throat of the

operator or his assistants supposedly masked. Fifth, they might come from the hands of the operators supposedly sterilized by the process of scrubbing with soap and water and soaking in antiseptics before putting on gown or glove.

Our chief and immediate concern was to find the source of the hemolytic streptococci which caused serious infections in 8 clean cases during the first 5 months of 1925. We cultured every kind of material which had been prepared for the sterile field—those which had been boiled, those which had been autoclaved, those which had been soaked in antiseptic—but found no trace of the hemolytic streptococcus. The sterile water tanks occasionally contained gram negative organisms but never a hemolytic streptococcus. The exposure of blood agar plates to the air of the operating rooms for several hours on many occasions yielded only one colony of hemolytic streptococcus. Cultures from the skin of the patient seldom gave this organism. It was only when we came to examine the hands and the noses and throats of the operating personnel that we found a field of activity for the hemolytic streptococcus. Much to our surprise 33 per cent of the operating room staff harbored this organism in the throat and many individuals carried it in the nose as well. This organism could also be recovered occasionally from the hands of the doctors. It was evidently picked up from the dressings and bedclothes of patients suffering from hemolytic streptococci lesions and may have been transferred by the doctor to his mouth. Cultures from the hands of the doctors just before dressing these cases seldom yielded these bacteria but directly afterward they were almost invariably present.

The nose and throat as sources for infecting bacteria. The above findings suggested the direction for our immediate researches. A survey of noses and throats of the entire operating personnel was made. Fortunately (and I use the word advisedly for I realize how lucky we were), just at that stage of our study a clean hernia developed a hemolytic streptococcus wound infection. When we looked up the record we found that 3 members of the operating team were carriers of the hemolytic streptococcus. It had been cultured from the throats of 2 of the doctors and from the nose

as well as throat of the instrument nurse, just a few days before the operation. By a strange coincidence also as it proved cultures of the patient's nose and throat yielded hemolytic streptococci. The question arose which of the extraneous strains matched the organism which had been recovered from the wound. By the injection of rabbits with the several strains, agglutinating sera were obtained and then by agglutination and cross absorption of agglutinin tests, it was indisputably shown that the organism from the wound was identical with the organisms from the nose and throat of the instrument nurse and entirely different from the strains from the patient's nose and throat and the strains from the 2 doctors. The evidence was overwhelming that the organism had been discharged from the unmasked nose or throat of the instrument nurse upon the sterile field. Thereupon the order went forth for all operating teams without exception to mask both nose and mouth with fine meshed 4 ply gauze masks. This measure, we found, reduced the number of organisms deposited upon a blood agar plate held in front of a person so masked to approximately the number deposited on a control plate some distance away. This complete masking was later extended to all persons both sterile and unsterile entering the operating room except the patient himself. Thereupon our hemolytic streptococcus wound infections were immediately reduced to casual numbers that could probably be accounted for by contamination from other sources.

Reports of this demonstration appeared in the literature (8-9) and individuals here and there profited by our experience but the matter has not received general recognition although Dr Staige Davis has recently called attention to it again. I have since seen, and you will see here in Boston as well as in Chicago, Philadelphia, Baltimore and in my own home town of New York surgeons who do not mask the nose and who do not know that they are subjecting their patients to an unjustifiable risk from the neglect of this one measure in sterile technique.

Dr Walker of this city was stimulated by a similar misfortune in his own hospital to study the problem of adequate masking and demon-

strated that the only germ-proof mask was one containing an impermeable membrane such as rubber. Its advantage over the 4 ply fine meshed gauze mask is apparent to any one who will take the trouble to blow smoke through these two masks, but the impermeable mask is far from ideal because of its discomfort and the other mask seems to be satisfactory for all practical purposes, for it will stop droplet contamination from both nose and mouth. The anesthetists objected to masking because they said it was difficult to breathe when the fumes of the anesthetic were added to the annoyance of the masks, but when they were exempt for a few months 3 cases of hemolytic streptococcus infection developed following thyroid operations and the proximity of the unmasked anesthetist in these operations rendered them suspicious sources of these organisms. Now there are no exceptions and if any member of the staff is known to have a cold he is either relieved from operating room duty or is required to wear two masks and to double the time for scrubbing and antisepticing his hands before operation.

We realized of course that the noses and throats of the operating personnel were not the only source of the organisms causing wound infections but this was the most significant finding in our first year's study and the statistics obtained for 1925 served as a basis upon which to measure any improvements in our sterile technique. The 1925 results proved to be of such interest and importance to the staff that it was decided to make it continuous. This has kept every member of the staff alert and "infection conscious" and has made us all strive continuously to improve our record.

The autoclaved materials as a source of organisms. We have maintained a continuous check on our autoclaves by inserting in the center of the material a cotton thread saturated with *Bacillus subtilis* spores and then testing for their destruction. In 1929 we changed the test organism to another strain and soon afterward began to obtain occasionally positive cultures. No change had been made in the sterilization process but we found that our new test organism would stand boiling for 15 min.

utes. Rather than to change back to a more susceptible test organism we decided to find a way of killing this resistant strain. Our sterilizing time had been 30 minutes at 18 pounds pressure preceded by an evacuation of the air just sufficient to reach minus 10 for a few seconds. With this amount of air evacuation we found that it took $1\frac{1}{2}$ hours to consistently kill our test organism in the center of the central drum, and this period of sterilization frequently scorched the materials and softened the gloves. By prolonging the evacuation time at minus 10 to 15 minutes however a sterilization time of 30 to 45 minutes was sufficient to kill the spores. Since that time we have followed this procedure and our tests have consistently yielded no growth. But, although Dandy claimed that the autoclaved materials are the sole source of organisms causing wound infections this change in our own technique has not stopped our wound infections.

Boiled instruments as a source of infecting organisms The boiling process for sterilizing instruments has proved to be effective in all of our tests and conscientious timekeepers who will wait for the full 5 or 10 minutes should have no fear of presenting unsterile instruments to the operating table. The chief danger from this source occurs when an instrument which has been forgotten or one which has been called for in a hurry is rushed through in less than the minimum time. To be sure, some heat resistant spores will withstand boiling for 5 minutes but so far as I can ascertain the only species which may do so are non-pathogenic, such as *Bacillus sporogenes* and *Bacillus subtilis*.

Instruments "sterilized" in antiseptics as a source of infecting organisms The sterilization of sharp instruments such as knife blades, scissors and needles as well as syringes, but tons, silk worm gut and catgut tubes has been a real problem. The odor from the apparatus and one fire made us give up the oil sterilization process advocated by Lahey and others. He found that soaking for 15 minutes in 50-70 per cent alcohol (our former method) was entirely inadequate to destroy even the commonest organisms. We experimented with various antiseptics by contaminating knife

blades with heavy suspensions of mixed bacteria and subjecting them to contact with these antiseptics for varying lengths of time. We found that the best antiseptic to sterilize and at the same time maintain sharpness was the Bard Parker germicide. We used that for over a year but finally had to yield to the protests of the nurses who handled those materials because severe burns of the skin resulted from contact with this germicide or its fumes. Furthermore, a number of severe reactions following spinal anesthesia, with central nervous system symptoms and increased cell count in the spinal fluid, were attributed to a small amount of this chemical having remained in the needle or syringe at the time of lumbar puncture. Occasionally also we produced skin necrosis with local anesthetics and the germicide was blamed. Now these instruments are either boiled or soaked in pure carbolic acid for 15 minutes. The Bard Parker germicide is still being used for the sterilization of the catgut tubes which contain the non-boilable variety of gut.

Catgut as a source of infecting organisms Catgut has often been blamed for wound infections and there is no doubt that it has been responsible for certain of the cases due to anaerobic spore-forming organisms such as the tetanus bacillus and the gas gangrene group of bacteria. These were more common a generation ago than they are now. Welch once said that these wound infections constituted one of the chief reasons why Halsted substituted silk for catgut as suture and ligature material (15). This point will be mentioned in more detail below. In 1923, before this study began, 2 postoperative infections due to *Vibrio septique* in the Presbyterian Hospital were directly traced to inadequately sterilized catgut. The catgut firm was made liable in a court of law. In 1927, while this study was in progress, the author was asked to see a patient with a postoperative wound infection in another hospital. The contamination was traced unmistakably to inadequately sterilized catgut sold by another firm. Death occurred in this case and in 4 other similar cases (16). This led to a study of the methods of catgut manufacture and its sterilization as well as tests for its sterility. Several of the catgut

firms followed this study closely and modified their methods according to its findings (11). A standard method of testing for sterility was developed (12). This has been accepted and is now said to be employed by most of the catgut firms. Unfortunately neither the American College of Surgeons nor the American Medical Association has been willing or financially able to set up a laboratory control for determining by periodic tests of specimens of catgut purchased on the open market whether or not the products now sold are measuring up to the standard of sterility. But the test for catgut sterility is one which can be carried out by any laboratory equipped for anaerobic bacteriology and until either the government or some medical organization undertakes to control these products, the proposed tests should be made in a reliable laboratory before any particular brand of catgut is adopted by any surgical clinic. Although improperly sterilized catgut may at times contain the organisms of tetanus or gas gangrene it probably very rarely contains non spore forming heat susceptible organisms like staphylococcus and streptococcus, which are the commonest organisms of operative wound infections. However as shall be seen presently the use of catgut in surgery may and almost certainly does favor the growth of organisms introduced at the time of operation.

Contamination from the hands of operators. We have stated above that doctors and nurses frequently contaminate their hands with purulent discharges from the wounds of patients when changing their dressings or handling their bedclothes. (If gloves are used at the time of dressings such contamination is minimized.) If the doctor or nurse then proceeds to the operating room the possibility of carrying those organisms to the sterile field is a very real one. The scrub-up is the intervening barrier. In almost every hospital the surgeons scrub their hands with soap and water for a variable length of time. In this procedure the time is not as important as the vigor with which the superficial layers of skin and the crevices and grooves are scrubbed. Countless organisms are removed in this process. The after treatment of hands then varies considerably in different clinics. Some use alcohol others

bichloride, biniodide, lime and soda, iodine, or a combination of these. The antiseptic effect of these chemicals depends upon their close contact with the bacteria and the duration of this contact. Our present technique calls for a 5 minute scrub-up with green soap in running water and 5 minutes by the clock in lime and soda, followed by 70 per cent alcohol. For those whose skin is irritated by the lime and soda, the time may be abbreviated but the nails must receive a generous supply and be cleaned with the antiseptic. The full time of 10 minutes must then be completed in the alcohol. Cultures from the hands and nails following this treatment rarely show organisms. Lime and soda seems to be particularly effective and the odor of chlorine may frequently be detected under the nails several hours after the operation is over. There is a tendency on the part of certain surgeons at times to shorten the various steps in the scrub-up and I am convinced that when this is done organisms are carried over to the sterile field. An added safeguard lies in having the sterile nurse hold the glove open so that the hand may be inserted without touching the outside. If gloves are broken or pricked during the operation, good practice demands a change at once because the hands, even if sterile at the beginning of the operation may be contaminated by skin organisms discharged from hair follicles or sweat glands later on. The method of using wet gloves makes it impossible to prevent contamination of the outside of the glove with organisms still present on the hands.

Contamination from the skin of the patient. In the earlier years of our study there was an urgent demand for a skin antiseptic to replace the time honored iodine which has been criticized because it occasionally produces burns and does not effect real sterilization of the skin. Picric acid acriflavine gentian violet mercurochrome various other dyes and combination of dyes, hexylresorcinol, metaphen and merthiolate have all been recommended by enthusiastic advocates and statistics have been presented to prove their worth, but the results that we have obtained in experimental animals have not consistently indicated the superiority of any skin antiseptic over the others. We at

tempted to compare iodine with mercuriochrome-acetone alcohol which was said to have extraordinary penetrating qualities. At the beginning of a hernia operation, 5 minutes or more after the antiseptic had been applied a bit of skin from the region of the pubic hairs was cut out with freshly boiled instruments and transferred at once to cultures medium. Of ten cases prepared with iodine 9 yielded growth of staphylococci, *Bacillus subtilis* or diphtheroid bacilli, 2 of these wounds developed trivial infections. Of 10 cases prepared with mercuriochrome 8 showed growth. One of these yielded *Bacillus coli*, *Bacillus welchii* and staphylococci and developed a serious infection "Not much to choose" you will say, "between the two both being inadequate skin sterilizers." That is true and we have repeatedly carried out this same test in animals with the other antiseptics. After contaminating the skin of rabbits with mixed cultures of common organisms—such as *Bacillus coli*, *Bacillus subtilis*, *Bacillus welchii*, staphylococci and streptococci we have applied the antiseptics for varying lengths of time and then snipped out bits of skin for culture. No antiseptic yet proposed has shown any superiority over iodine.¹ If the organisms in the deep glands and ducts of the skin cannot be destroyed by any antiseptic yet found, the knife which passes through these ducts and glands must contaminate the wound with the organisms contained therein. This might be avoided by using the electric 'cutting current' or by employing a knife blade soaked in carbolic acid. However the injury to the tissues from cautery or antiseptic might offset the advantage gained. If a knife is used it may be discarded when the skin has been incised. Greater contamination of the wound may take place during the course of the operation if the neighboring skin surfaces are exposed, for the skin secretions almost certainly wash out bacteria from the ducts during the course of an hour and these reaching the surface may be wiped into the wound unless the skin edges are protected. This may be done most effectively by attaching towels to the skin margin with Michel clips

The bacteria contained in the deep ducts and glands may again become of some importance during the skin sew up. If a continuous suture is used the needle may pick up organisms and distribute them all along the suture line. This source of contamination may be minimized by using individual interrupted stitches on separate needles as Halsted advised.

Contamination of the wound from air organisms. Lister believed that organisms dropping from the air played an important rôle in wound infection and developed his elaborate apparatus for spraying the atmosphere. It later developed that this was one of the relatively minor factors. However with the other sources greatly reduced or eliminated if nothing is done to minimize contamination from this source it becomes relatively important again. If a blood agar plate is exposed to the air of an operating room for an hour and then incubated, its surface will be more or less thickly covered with dust particles and beneath some of these particles colonies of bacteria of various kinds develop. Staphylococci will make up the majority of these colonies. Yellow and white, hemolytic and non hemolytic will all be represented. *Bacillus subtilis*, *Bacillus coli*, non hemolytic streptococci and diphtheroid bacilli will be present in smaller numbers. Hemolytic streptococci will appear rarely. Yeasts and moulds are relatively common. The number of colonies will depend upon a number of factors. In the old hospital one operating room was on the ground floor and a second on the floor above. Cultures from the ground floor operating room were consistently more numerous than those from the upper floor and yielded roughly two colonies for every minute of exposure. In the new hospital, with the operating rooms on the sixteenth floor, the colonies were found to be just half as numerous as they were in the old hospital, namely, one colony per minute of exposure. The fresh air supplied to these rooms is filtered. But this filtration is nullified by the opening of doors, the occasional coming and going of assistants, the spread of blankets and the general movement of the people connected with the operation. If plates are exposed in one of these rooms when no operation is going on and no

¹Emphasis should be made of the importance of a careful preliminary gauze sponge scrubbing of the field with alcohol and then either or other alone before applying the iodine.

TABLE I.—THYROID OPERATIONS

	Total	Infected	Per cent	Healed	Per cent
1906	37	10	8	6	36
1907	77	3	77	30	30
1908	78	5	70	29	37
1909	153	20	5	60	38
1910	159	4		20	5
1910 Catgut	33		6	5	43
1910 Silk	54			4	9
1911	216	4		29	3

1910 Average number days in hospital catgut cases

1910 Average number days in hospital silk cases

one moving in or out the number of colonies appearing on the plates is just one tenth of that developing on plates in a room where there is activity during an operation. In these rooms visitors are required to observe the operations from a balcony protected by plate glass. If visitors are permitted to come on the floor of the operating room as is the case in many places, it is obvious that the number of air organisms are materially increased, especially when the visitors are not properly masked.

The area of a blood agar plate is approximately 7 square inches. The sterile field including the operating table and instrument tables might vary from 4,000 to 7,000 square inches. It would seem fair to assume, therefore that in a busy operating room in the course of an hour from 35,000 to 60,000 bacteria fall upon the sterile field. It is obvious that these figures may be materially reduced by minimizing the activity within the room and the opening and closing of doors, by removing objects which collect dust, and by refusing admittance to unnecessary persons.

Canopies over instrument tables cut down air contamination. Street shoes should be covered. Walls and floors should be frequently washed with germicides. Constant filtration of the air might be of considerable value, where dust is prevalent.

FACTORS WHICH FAVOR THE DEVELOPMENT OF WOUND INFECTION

The factor of local tissue susceptibility. During the first 5 years of our study our chief efforts in our attempts to reduce the number of our infections, lay in considering ways and means of reducing the sources of contamination. It is obvious that every wound becomes contaminated at the time of operation but fortunately relatively few become infected. One reason for this, which we assume but cannot prove, is that individual patients may vary in their susceptibility to infection. It is almost self-evident also that trauma and rough handling of tissues decrease the local resistance to infection. Extravasation of blood the use of drains mass ligation of tissues and the tension upon or strangulation of tissues by sutures or retention stitches as well as the mechanical factors of motion (as in certain wounds of the face neck, and extremities) or distention from within (as in abdominal wounds) play a rôle by breaking up the fine fibrous network of the early stages of repair or by cutting down the blood supply.

The factor of suture material. During the first 5 years of our study it was evident that certain types of operation regularly had a higher incidence of infection than others. Radical mastectomy partial thyroidectomy recurrent hernia, ventral hernia, open reduction of fractures headed the list. There seemed

TABLE II.—1911 SILK VERSUS CATGUT

	Inguinal Hernia						Fracture Surgery					
	Total	Healed	Per cent	Ser	Trav	Per cent Inf	Total	Healed	Per cent	Ser	Trav	Per cent Inf
Catgut	100	14	14		4	5	38		29	5	5	18
Silk	49						79					
Silk and Catgut	8		5		3	38	10	4	40			20
Not stated	5						20					
Total	164	14	20		7	5	127	18	12		6	6

TABLE III.—1932 SILK VERSUS CATGUT

	Silk					Catgut					Both					Not Rated				
	Total	Healed	Per cent	Inf.	Per cent	Total	Healed	Per cent	Inf.	Per cent	Total	Healed	Per cent	Inf.	Per cent	Total	Healed	Per cent	Inf.	Per cent
All cases	656	50	4.6	15	2	306	30	6.5	38	0.3	10	0	0	0	0.5	72	5	31	11	13
Inguinal hernia	113	4	3.5	5	0.6	16	4	11			56	8	0	0	0.3	1	0	0	0	0
Central hernia	15	0	0	0	0	13	0	0	4	30	0	0	0	0	0	0	0	0	0	0
Radical mastoid	6	1	17	1	17	7	1	14	1	28	0	0	0	0	0	7	3	71	4	57

to be a reason for this in the nature of the operation except in the case of partial thyroidectomy. Practically all of the thyroid operations were being done by the two surgeons associated with the thyroid clinic and it did not seem possible for them to reduce their high incidence of hematoma and infections. In the summer of 1929, while one of the thyroid surgeons was on his vacation the author had the opportunity of performing 3 thyroid operations in close succession. As had been his habit since his experience in thyroid surgery in Peking China, under the leadership of Dr. Adrian S. Taylor, a former pupil of Dr. Halsted, the author used fine silk entirely for ligature and suture material in these cases. The differences in the healing of these wounds compared with the catgut sutured wounds was obvious to all who saw them. The second thyroid surgeon observed these results and was persuaded to

try silk. He performed 10 consecutive cases with silk, all of which healed promptly and kindly without trace of hematoma or infection. He then sutured 10 cases with catgut and obtained 4 hematomata and 2 infections. He was convinced of the superiority of silk and determined to use it entirely thereafter. Some months later the other thyroid surgeon was also persuaded to make the change. The results which were obtained were most surprising and most convincing. These are shown in Table I. When the report of the year 1930 was presented to the staff it was suggested that the use of silk be extended further particularly to those cases which were yielding such a high percentage of infection, namely open reduction of fractures, recurrent hernias and radical mastectomies. The fracture service surgeons decided to use it for all of their clean cases and a certain group of the general

TABLE IV.—1933 WOUND INFECTIONS IN RELATION TO SUTURE MATERIAL.

	All Cases												Thyroids											
	Total	Clean	Per cent	Scar	Per cent	Trich	Per cent	Total Inf.	Per cent	Hem.	Per cent	Total	Clean	Per cent	Scar	Per cent	Trich	Per cent	Total Inf.	Per cent	Hem.	Per cent		
Silk	594	511	97	1	0.6	11	1	15	1	20	4	107	107	100	0	0	0	0	0	0	11	11		
Catgut	351	329	97	0	0	13	7	20	3	27	8	0	0	0	0	0	0	0	0	0	0	0		
Lacer.	138	128	96	4	1	1	0	6	4	13	10	150	123	85	1	1	1	1	6	1	12	0		
Cornuhead	11	10	92	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0		
Not stated	104	105	97	2	1	1	1	1	1	1	1	11	11	100	0	0	0	0	0	0	0	0		
Total	118	107	95	12	1.3	41	16	14	3	62	22	247	241	98	1	1	1	1	6	1	24	10		
	Primary Inguinal Hernias												Radical Breasts											
	Total	Clean	Per cent	Scar	Per cent	Trich	Per cent	Total	Inf.	Per cent	Hem.	Per cent	Total	Clean	Per cent	Scar	Per cent	Trich	Per cent	Total	Inf.	Per cent	Hem.	Per cent
Silk	141	137	97	1	0.7	1	1	4	1	1	0	0	100	0	0	0	0	0	0	0	0	0	0	
Catgut	40	38	95	1	1	0	0	1	1	1	11	10	6	60	0	0	4	40	4	40	1	10	10	
Lacer.	4	4	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Not stated	3	3	100	0	0	0	0	0	0	0	0	0	1	1	100	0	0	0	0	0	0	0	0	
Total	188	182	97	2	1	1	1	6	2	1	1	11	11	79	0	0	5	11	6	11	1	11	11	

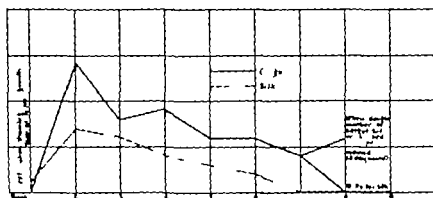


Fig. 1. Silk and catgut sutures comparisons.

surgeons agreed to use it on all hernias. In the next year's report an opportunity was given to compare silk and catgut in these 2 large groups. Again the superiority of silk was demonstrated unmistakably as Table II shows clearly. In the last 2 years silk has been substituted more and more for catgut. In 1932 we were able to compare silk and catgut in 3 large groups (see Table III). In 1933 a large majority of all clean wounds were sutured with silk. For the first time we were able to compare all of the cases closed with silk with all of the cases closed with catgut (see Table IV). The results amply confirm the early reports and we have come to feel that this one modification in our technique has been more important than any other in reducing our wound infections. In 1933 the 2 thyroid surgeons experimented with linen as a substitute for silk but their results were unsatisfactory as Table IV so clearly shows.

As we have said above Halsted, following the lead of Kocher in Berne, substituted silk for catgut in suturing clean cases partly because of the uncertainty of catgut sterilization in those days, and partly because he noticed that the wounds healed "more kindly" even when there was no infection. There was less redness, swelling and induration. Thus he became the chief advocate of the use of silk in this country and his pupils have almost all followed his example and spread this gospel abroad. On the other hand few surgeons who did not come under his influence either directly or through his followers and pupils have been convinced that he was eminently right in his

conviction nor have they been willing to change their technique in this respect.

It seems strange that Halsted did not attempt to prove his point either by well controlled clinical or careful laboratory experiments. He was sure of his ground on the basis of his own experience and his own observations. In 1925 B. H. Goff made a study of wound infections in clean cases and presented fairly good evidence that wounds sutured with silk were less likely to become infected than when other materials were used. Our results amply confirm the impression which he obtained from his study. During the past year Vivier one of the senior fellows in our surgical department, at the suggestion and under the supervision of the director of the service, has added clean-cut evidence from a series of animal experiments, which strongly supports the view that silk is superior to catgut. With rigid operating room technique he produced two wounds extending through the wall of the abdomen in a large series of rabbits. One side was sutured in layers with finest silk and the other with the finest catgut. Each side was operated on with completely separate sterile set ups and took the same length of time. One animal in the series was sacrificed each day for 10 days. Cultures were made from these wounds in a dust proof chamber and by taking approximately 1 cubic centimeter of tissue from each side an effort was made to estimate the number of viable bacteria actually present on its surface by shaking the tissue in 5 cubic centimeters of broth and diluting this down through a series of 1 to 5 dilutions.

TABLE V—ASSOCIATION OF DRAINS AND HÆMATOMATA WITH INFECTION—AVERAGE 7 YEARS

	Per cent
Drained, Infected	11.5
Not Drained, Infected	7.6
Hæmatoma, Infected	20.4

TABLE VI.—PROBABLE SOURCE OF INFECTION—1931

	Serious	Trivial
Contaminated at operation	11	54
Contaminated at dressing	2	15
(Vibri) contaminated before operation?	3	2
Questionably counted	8	3

TABLE VII—DAYS IN HOSPITAL AFTER OPERATION—AVERAGE 5 YEARS

Clean	12.4 days
Infected	23.3 days
Hæmatoma	10.1 days

In practically every case the catgut wounds contained more bacteria than the silk wounds as Figure 1 shows. Microscopic sections showed that the cellular and fluid exudation around the strands of catgut was infinitely greater in amount than around the silk. Therefore we now have both clinical and experimental evidence of the superiority of silk (Fig. 1).

We believe that the superiority of fine silk over catgut is due to the following facts. First of all hæmostasis is better, for the silk knots do not become untied as easily as catgut knots, particularly when the wound surfaces move more or less constantly as in the thyroid operation. Second, the cellular and fluid reaction about silk is minimal while the reaction about catgut is maximal. Silk is almost inert in the tissues. Catgut is dead tissue which must be digested. In the third place the use of silk automatically requires the surgeon to be more gentle with the tissues. His sutures and ligatures are less likely to be pulled tightly enough to strangle tissue. This often happens when catgut is used and increases with the postoperative oedema. For these reasons, with a certain inevitable amount of bacterial contamination, infection is more apt to develop in tissue in which catgut has been used than where silk has been employed. Halsted observed, and our statistics as well as our tissue sections prove, that wounds sutured with both silk and catgut are more apt to

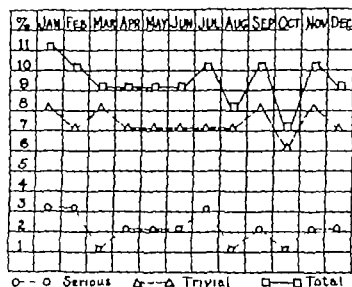


Fig. 2. Seasonal incidence of wound infection composite curve of 9 years.

become infected than when either is used alone. This is probably due to the fact that in a wound in which organisms are able to gain a foothold easily, silk acts as a foreign body which must be extruded. For the same reason silk should not be used in clinics or by operators who are not willing to strain every effort to minimize contamination by all of the methods mentioned above which have been devised for that purpose or by those who are not willing to minimize trauma to the tissues or tension of the tissues during the operation or by those who are not willing to take the time to obtain perfect hæmostasis, or by those who are not willing to mask adequately both nose and mouth. My chief Dr. Allen Whipple, emphasized these points in an admirable review of the subject which appeared last year in the *Annals of Surgery* and I desire to reiterate them emphatically here. However, I am willing to predict with confidence that any surgeon who will perfect his technique in these respects will be able to obtain "kindlier" wound healing with fine silk than he is now obtaining with catgut with or without those refinements of technique.

The rôle of drains and hæmatomata. During 7 of the last 9 years we have studied the rôle of drains in the production of infections. In every year but one, a larger per cent of infections developed in the drained cases than in the undrained and the average per cent of infections in drained cases greatly exceeded that in

TABLE VIII—WOUND INFECTION 9 YEARS

Year	Total	Clean	Per cent	Serious	Per cent	Terminal	Per cent	Tot. Inf.	Per cent	Healed	Per cent
1943	158	43	26	20	4	56	20	76	14	77	5
1944	58	404	85		4	65		87	5	34	9
1947	643	115	85	16	3	8		95	5	95	14
1948	620	571	89	12		29	9	69		80	3
1949	77	703	94	7		5	7	68	9	14	18
1950	77	674	90	3	3	20	7	73	10	63	4
1951	159	843	91	6	7	5	54	67	7	97	10
52	653	907	95			44	4	56	53	27	54
1953	34	976	95	3		45	36	54	48	63	55

the undrained cases, but we cannot be sure whether this was due to the drains or to the condition which seemed to the surgeon to require drainage (Table V). There is no question, however, about the rôle of hematomata. Wounds which develop collections of blood or serum are unquestionably more prone to become infected either because of organisms introduced during the operation or later during dressings. Our studies have seemed to show that wounds may become infected following secondary contamination at the time of dressings as well as primarily from contamination introduced at the time of operation. This applies chiefly to wounds which develop hematoma or necrosis of skin from excessive tension. In a few cases each year there has been a good excuse for the development of an infection independent of the operating room technique. These points are brought out in Table VI.

PROLONGED HOSPITALIZATION OF INFECTIONS

It seems important for surgeons as well as hospital superintendents to know that patients with clean wounds which become infected have to stay in the hospital about twice as long as they would if their wounds had remained clean. This fact is shown in Table VII.

ANNUAL RESULTS FOR NINE YEARS

During the past 9 years we have gradually modified our operating room sterile technique to conform with the facts which we have presented above and we have gradually reduced our infections to a third of the former figure, as Table VIII shows. Time will tell whether

or not we have reached the irreducible minimum.

The composite curve showing the seasonal incidence of wound infection is shown in Figure 2. It does not show the spring peak which appeared in Dr. Walker's curve and in our own (7) when hemolytic streptococcus was prevalent before the period of adequate masking.

SUMMARY

1. We have carefully studied the question of the infection of clean operative wounds and have shown that general impressions of the incidence of wound infection is erroneous unless backed up by carefully prepared statistics.

2. We have considered the possible sources of contamination and we believe that the important origins are (a) the nose and throat of the operating personnel, (b) the hands of the operating personnel, (c) the skin of the patient, (d) the air of the operating room and (e) the instruments and materials used in the operation.

3. We have suggested ways and means of minimizing contamination from all of these sources, placing particular emphasis on efficient autoclaving and the proper masking of the nose and mouth of the operating personnel.

4. We have considered also the factors in the wound itself which favor the development of an infection, laying particular stress upon the advantages of fine silk over catgut as ligature and suture material. We have stressed the necessity for perfecting all of the steps in sterile operative technique if fine silk is to be used successfully.

5. We have shown a steady improvement in avoiding wound infection following the

gradual modification of our technique based upon results of our study

6 The study has been of interest to every member of the staff. It has rendered him "infection conscious" and stimulated his efforts to reduce further the incidence of wound infection.

7 Theoretically, there is an irreducible minimum in the incidence of wound infections. We do not claim to have arrived at that point

BIBLIOGRAPHY

1. BREWER, O. E. Studies in aseptic technique. *J. Am. M. Ass.*, 1915 64 1369-1372.
2. DAWDY, W. E. The importance of more adequate sterilization processes in hospitals. *Bull. Am. Coll. Surg.*, 1932 16 11-12.
3. DAVIS, J. S. The importance of adequate masking during operation. *Ann. Surg.*, 1934, 100 1008-1015.
4. GOTT, B. H. Analysis of wound union in 3000 abdominal incisions based on Woman's Hospital classification of wounds and wound union. *Surg. Gynec. & Obst.*, 1935, 41 723-739.
5. HALLISTED, W. S. Ligature and suture material. The employment of fine silk in preference to catgut. *J. Am. M. Ass.*, 1913 60 1119-1126.
6. LARLEY, F. H., and MARROW, R. L. Oil sterilization of eined instruments. *Surg., Gynec. & Obst.* 1925 41 226-228.
7. LISTER, SIR, J. Quoted by Kern, W. W. Before and after Lister. *Scl.* 1915 41 815-833.
8. MELENEY, F. L., and STEVENSON, F. A. Postoperative hemolytic streptococcus wound infections and their relation to hemolytic streptococcus carriers among the operating personnel. *Surg. Gynec. & Obst.* 1926 43 338-342.
9. MELENEY, F. L. Seasonal incidence of hemolytic streptococcus in the nose and throat in surgical operating personnel: significance of masking during operation. *J. Am. M. Ass.*, 1927 88 1599-1604.
10. MELENEY, F. L., HUMPHREYS, F. B., and CARP, J. Unusual fatal operative wound infection yielding a pathogenic anaerobe of the gas gangrene group not hitherto described with direct reference to catgut as the source. *Surg. Gynec. & Obst.* 1927 45 775-789.
11. MELENEY, F. L. and CHATFIELD, M. How can we insure the sterility of catgut? *Surg. Gynec. & Obst.*, 1930 50 21-27.
12. Idem. The sterility of catgut in relation to hospital infections. *Surg., Gynec. & Obst.*, 1931 52 430-441.
13. VIVIER, P. The bacteriology of celiotomy wounds sutured with catgut and silk. Part of thesis presented to Columbia University for degree of Master of Medical Science, 1934.
14. WALKER, I. J. How can we determine the efficiency of the surgical mask? *Surg. Gynec. & Obst.* 1930, 50 266-270.
15. WELCH, W. H. Personal communication.
16. WHIFFLE, A. O. The use of silk in the repair of clean wounds. *Ann. Surg.* 1933 98 662-671.

Discussion

DR. IRVING J. WALKER, Boston. With the short period of time allotted for the discussion of Dr. Meleney's interesting paper, I shall consider only one aspect of the infections of clean surgical wounds, namely that of the so called epidemic hemolytic streptococcus infection occasionally occurring on surgical services.

The late Dr. Arthur T. Cabot, surgeon to the Massachusetts General Hospital once made the statement that every surgical operation was an experiment in bacteriology. If one accepts the fact that all surgical wounds, the clean as well as the infected are accompanied by bacteria from an extrinsic source, then one can appreciate the wisdom of the above statement. Fortunately in the case of the clean surgical wound these bacteria are usually not pathogenic and therefore cause no harm.

When, however, there chances to be a strain of pyogenic organisms of considerable virulence and as a contributory factor a lowered resistance on the part of the individual, an infection of the wound may result, with its morbidity and possible mortality.

It so happens that we have had the opportunity to observe 4 epidemics of hemolytic streptococcus infection, 3 on surgical services and 1 on an obstetrical service in Massachusetts hospitals. In 2 of these—both surgical—we were able to study the epidemic somewhat carefully.

We have considered as an epidemic of wound infections due to the hemolytic streptococcus a situation where there were 3 or more infections of clean surgical wounds due to the above mentioned organisms occurring on a service simultaneously or at near intervals. As a result of observations and a study of masks, we have made the following findings which may be of some value in the prevention of hemolytic streptococcus wound infections of the epidemic nature.

1. In the 4 epidemics cultures from the hands, sterile goods, instruments, solutions etc., showed no evidence of the hemolytic streptococcus.

2. Study of the masking situation showed that masking was inefficient in the 4 epidemics.

3. All 4 epidemics of sepsis occurred during epidemics of respiratory disease.

4. Three out of the 4 epidemics of infection occurred during the winter months when epidemic respiratory disease is most prevalent in this part of the United States.

5. In the 2 epidemics, both surgical, more carefully studied, the percentage of streptococcus carriers in the operating room personnel including the surgeons, was 50 per cent and 58 per cent respectively.

Among those patients with clean wounds which became infected with the hemolytic streptococcus, the percentage of those having hemolytic strepto-

cocci in the nasopharynx in the 2 epidemics studied was 33 per cent and 31 per cent respectively. In fairness it should be stated that all bacteriological studies in these 2 epidemics were made after the sepsis was discovered.

6. A study of masks submitted from 60 hospitals in the United States showed that none could be considered efficient from the point of view of preventing the passage of organisms through the material under all the conditions for which a mask might be called upon for service and that the variables in the efficiency of the masking situation were as follows: (a) whether or not the nose as well as the mouth was covered (b) materials used in the mask (c) thickness of the material (d) duration of the operation (e) whether or not the mask became moist (f) the amount of conversation carried on by those masked.

7. We concluded that the ideal surgical mask should be one that—(a) under all conditions will absolutely prevent the passage of organisms through the material of the mask in the direction of the wound or material concerned with the operation when both the nose and the mouth are covered (b) will be comfortable in all degrees of temperature

and will not fog glasses (c) will be of low original cost or of such construction that it can be used economically many times with sterilization following each use. (We might state in passing that we have not found the ideal surgical mask.)

8. Theoretically if all other aspects of aseptic technique can be assured epidemics of haemolytic streptococcus wound infection can probably be prevented by eliminating from the operating room all who are streptococcus carriers. This seems not to be feasible because of the rapidly changing bacteriology of the nasopharynx. The danger of such epidemics can be lessened by forbidding any individual who has the slightest inkling of an upper respiratory tract infection to enter the operating room. A practical procedure to minimize such infections should be the use of a mask during epidemics of respiratory disease and during the winter months, the materials of these masks to be impervious to currents of air, even though they are not as comfortable as could be desired.

We offer for further intensive study the query as to the likelihood of haemolytic streptococcus carriers among surgical patients infecting their own wounds by the haematogenous route from a focal infection.

INFECTIONS OF THE LIP AND FACE¹

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MOST of the infections of the lip and face do not give rise to serious symptoms, but heal spontaneously without treatment. Any infection of these parts is, however, potentially grave and may present a problem that taxes the skill of the surgeon to the utmost.

The face is so closely related to many important structures that a comprehensive presentation of the subject should include a discussion of infections of all of them. This is clearly beyond the scope of this paper and discussion will, therefore, be limited to infections of the lip and to some of the organs from which extension of infection may involve the face.

A facial infection may spread by one or more of 3 routes—*anatomical continuity*, the vascular system, and the lymphatic system. Since the proper diagnosis and treatment of facial infections requires an exact anatomical knowledge, the anatomical aspects of the subject will be emphasized in this article.

FASCIAE AND FASCIAL SPACES

Spread of infection by anatomical continuity is directed by 2 types of fascial planes, those associated with muscles and those associated with viscera and vessels. The fasciae that enclose the facial muscles though continuous with certain cervical fasciae form discrete potential spaces because these fasciae are attached to periosteum which creates a barrier between the facial and cervical spaces. Infection in these facial spaces therefore tends to remain limited to them without spreading to the neck. The fasciae surrounding the viscera and vessels, however, form spaces that are continuous between the face and neck, with the result that infection may pass uninterrupted from the face to the neck or in the reverse direction.

In the face there are 3 muscular fascial spaces and 1 vascular visceral space. The superficial cervical muscular fascia which encloses the sternocleidomastoid and trapezius

muscles, fuses above the hyoid bone with the middle muscular fascia, which splits to enclose the sternohyoid and omohyoid muscles. The fused fasciae ascend to the inferior border of the body of the mandible and there the tissue divides into a superficial and a deep layer. The superficial layer, shown in Figure 1, attaches to and reinforces the periosteum of the anterior aspect of the body of the mandible and also covers the masseter muscle and passes deep to the parotid gland its ducts and the facial nerve and vessels. The deep division of the fused fascia attaches to and reinforces the periosteum of the posterior aspect of the mandible (Fig. 2) and continues upward to surround the internal and external pterygoid muscles forming their fascial covering.

Space of the body of the mandible. On the free buccal portion of the mandible the periosteum is covered by the gingival mucous membrane while inferiorly the periosteum is reinforced by the above-mentioned fascia and by muscle insertions. The fascial space between the superficial and deep divisions of the middle muscular fascia may be called the space of the body of the mandible (Fig. 4). It has an important relationship to infections of this bone. Because of fascial attachments osteomyelitis of the body of the mandible is barred from spreading either superficially or deeply. The infection may remain localized, may discharge into the mouth, or may spread to the masticator fascial space. The space of the body of the mandible may be drained through the mouth by means of an incision through the gingival mucous membrane of the vestibule or by an incision through the skin along the inferior border of the body of the mandible, which incision must be carried directly to the bone in order to open the space.

Masticator space. The second muscular fascial space is occupied by the ramus of the mandible and is bounded externally by the masseter muscle, internally by the pterygoid muscles, and superiorly by the temporal muscle. These structures, as already stated, are

duct, with irrigation of the duct system. Desjardins has had good results from treatment by X ray but considers radium more convenient for the patient. Favorable results when they occur are noticed within 48 hours. Blair (3) advises radical drainage of the lesion if it has progressed for 48 hours.

It would seem the part of wisdom to utilize the more conservative methods early and in the University Hospital we give treatment by radiotherapy either with radium or the X ray as soon as the swelling in the parotid is noticed. At the same time the duct is dilated so that drainage from that avenue may be possible. If however the lesion is not favorably affected by these methods, it is not wise to wait indefinitely for the appearance of fluctuation before instituting drainage of the gland. The parotid has a fibrous covering of such density that death from sepsis may occur before fluctuation is detectable. If the process is still active and progressive on the third to fourth day in spite of conservative treatment and if the patient's condition usually determined by the concomitant lesion permits, the drainage already described should be carried out and the entire gland including the deep portion should be explored and drained.

VISCEROVASCULAR FASCIAL SPACES

The three muscular fascial spaces of the face have been briefly outlined in relation to their surgical importance. In Figure 9 is shown a surface projection of these spaces. The only viscerovascular space that need be considered in relation to the face is the lateral pharyngeal or pterygopharyngeal space which is shown in vertical and horizontal section in Figures 1 and 3. This space is of great importance to the otolaryngologist but is involved so frequently in cases of some of the more superficial infections that it must be briefly considered here. It is bounded anteriorly by the mesial wall of the masticator space laterally by the parotid space posteriorly by the carotid sheath and its contents and medially by the pharynx and its fascia. Above it is limited by the base of the skull and below by the submaxillary gland with its fascial sheath.

Infection of the pterygopharyngeal space as already indicated may result from such in-

fections in the lateral wall of the pharynx as tonsillitis or peritonsillar abscess. The space may become infected secondary to infections of the retropharyngeal or the parotid space, but not from the masticator space since the internal pterygoid muscle intervenes between these spaces.

Once infection has reached the lateral pharyngeal space the internal carotid artery is in danger of necrosis and the internal jugular vein is liable to septic thrombosis. It is apparent, therefore that infections in the parotid gland may result in the grave complication of hemorrhage from the internal carotid artery or septic thrombosis of the internal jugular vein. Early drainage of parotid infections will often prevent infection of the pterygopharyngeal space. The space should be drained either internally through the lateral pharyngeal wall or externally as indicated in the description of the method of draining the deep portion of the parotid gland. If even a mild hemorrhage should occur the common carotid must be immediately ligated. As stated at the outset infections in spaces formed by vascular fascial planes easily follow these planes to adjacent areas. Infection in the lateral pharyngeal space passes without hindrance into the carotid and jugular sheath and thence into the vascular visceral spaces of the neck and mediastinum.

Another small space of some surgical interest may be seen in Figure 3 between the jugular vein and the stylohyoid and digastric muscles. It contains lymph nodes of the deep cervical chain that drain the above mentioned regions and may be the site of severe lymphangitis and abscess formation which infection may extend along behind the carotid sheath to the supraclavicular fossa. Infection in the space between the jugular vein and the stylohyoid and digastric muscles gives rise to marked tenderness along anterior and posterior borders of the sternocleidomastoid muscle.

UPPER LIP AND NOSE

The last important region of the face to be considered is that bounded laterally by the masticator spaces, inferiorly by the lower border of the mandible and superiorly by the hair line. In this region lie the lips, nose, cheek,

palpebral regions, and forehead. The organs of the special senses present highly special problems that should not be considered here. This region is covered by loose skin and subcutaneous tissue. Underneath lie the muscles of expression that take origin from the bones of the face and that are inserted into the deep portion of the skin. These muscles do not have a fascial covering but are surrounded by subcutaneous tissue. Therefore in this region there are no fascial planes to limit infection, which spreads easily in the subcutaneous tissue.

A rich plexus of vessels lies deep to the muscles of expression, they, too, are surrounded by the subcutaneous tissue. The skin, being attached directly to the muscles of expression, is almost constantly in motion. In this respect it differs from the skin of the rest of the body. The relative immobility of the facial skin tends to prevent the localization of infection. The venous drainage of this portion of the face is collected by the facial vein and normally carried to the internal jugular vein. There are no valves in the veins of the face and their walls are less flaccid than those of other veins because of the firm support afforded by the sub-



Fig. 1. Dissection of the first muscular fascial plane of the face and neck, and its continuity. This plane can be seen deep to the parotid gland, its duct, and facial nerve and vessels. A. Skin B. platysma and subcutaneous tissue C. parotid, masseter space D. parotid E. external jugular F. great auricular G. first muscular fascial plane.

cutaneous tissue. A tributary of the facial vein, the angular vein, anastomoses with the superior ophthalmic vein, which in turn empties into the cavernous sinus. Under normal

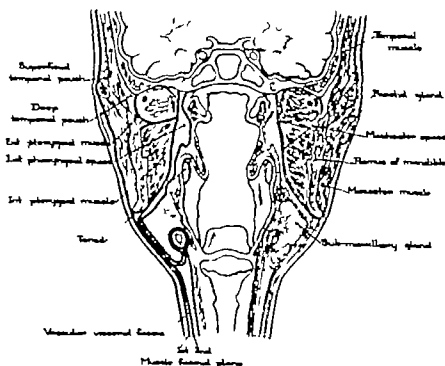


Fig. 2. Frontal section demonstrating the different fascial planes and potential anatomical spectra.¹

¹Drawings from dissection by authors.

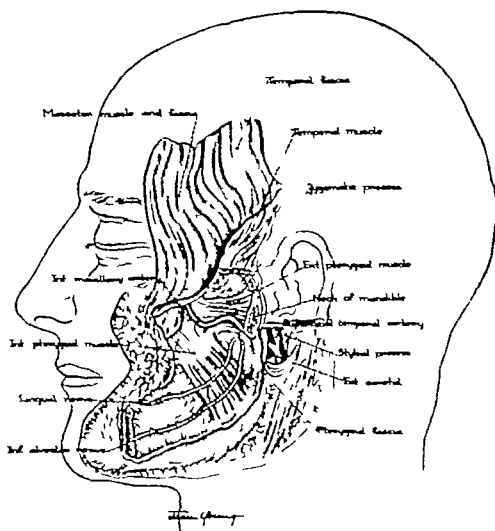


Fig. 6. Dissection of the medial wall of the masticator space after reflection of the external wall and removal of the mandible. The pouch of the deep portion of the parotid gland can also be seen as the parotid gland has been removed. (See footnote, Fig. 5.)

it with the cavernous sinus. When the facial vein or its tributaries are obstructed by thrombophlebitis or by pressure from oedema or exudate the current may be reversed and septic emboli may pass to the cavernous sinus, resulting in bacteraemia, meningitis or sinus thrombosis. Progressive thrombosis of the facial, angular, and superior ophthalmic veins may eventually reach the cavernous sinus. Infections of the upper lip, the external surface of the nose, and the external nares are all ways in danger of developing these highly fatal complications.

Infections in the upper lip may be due to streptococci entering cracks and fissures at the junction of the nasal mucous membrane and the skin, in this case erysipelas of the face

results. A more serious type of infection arises from staphylococci with invasion of the skin and soft parts of the lip itself. Such an infection may range from tiny pustules to a carbuncle involving the entire face. Certainly the huge majority of pustules are self limited and cause no more than a slight annoyance. At any time injudicious treatment by patient or surgeon may change the clinical picture from a harmless lesion to one that may be rapidly fatal. It is well to emphasize the fact that bacteraemia, meningitis, and cavernous sinus thrombosis may develop from a traumatized pimple. Squeezing a pimple endeavoring to abort a pustule or furuncle by incision or by the introduction of an antiseptic may initiate the spread of infection by continuity

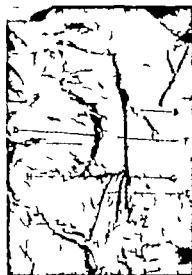


Fig. 7. Dissection showing the superficial portion of the parotid gland and its internal and external relations to the facial nerve. The space between the masseter muscle and parotid gland is well shown. A. Skin. B. subcutaneous tissue. C. masseter muscle and fascia. D. parotid masseter space. E. external jugular vein. F. parotid gland. G. greater auricular nerve. H. superficial portion lower pole of parotid gland.

and by the blood stream. It is probable that the great majority of severe infections of the upper lip and nose were originally mild infections that were converted to severe infections by ill advised treatment.

TREATMENT OF INFECTIONS OF THE UPPER LIP

The treatment of these infections will vary in character with the location, size and stage of the infection. First, no pimple or pustule, no matter how small, should be squeezed or traumatized. J. B. Brown's (4) suggestion of covering the pimple with adhesive plaster in order to splint and protect it seems a sound one. In from 1 to 2 days the lesion should have virtually disappeared.

Any infection larger than a pimple, such as a furuncle or carbuncle in the lip and nose, should be treated by bed rest in a hospital. The results obtained from radiotherapy in the hands of many observers, is so favorable that some form of this therapy should be tried. It may abort the early lesions and break down the late ones. This treatment should be given at the earliest possible moment in order to produce the best results. When a carbuncle

exists every effort should be made to reduce the activity of the lip to a minimum. Talking should be prohibited and in extensive lesions feeding by a nasal tube should be used. A hot moist dressing gives comfort and perhaps aids in recovery.

When the process has extended more widely with the signs and symptoms of generalized infection present, it is possible that septic thrombophlebitis is present and one is faced with deciding whether to ligate the angular vein. There is no unanimity of opinion on this question. Brown (4) writing from the service of Vilray Blair states that ligation of the angular vein is not practiced in that clinic. Sehlleau in 1910 and Bullock in 1912 reported a case of ligation of the facial vein for cellulitis of the lip with recovery. Roeder reports a favorable result from this procedure and Hamilton Bailey advocates the measure and reports 3 favorable cases. In the face of a lesion of such potential gravity it would seem advisable to carry out an operation of a minor nature such as this if there is a chance of preventing generalized infection or cavernous sinus thrombosis. If carefully performed with a small amount of local anesthesia, the procedure can hardly be said to increase the dangers of the disease. Bailey states that a sign which foretells impending danger is spreading edema from the lip to the inner canthus and this is usually found in the presence of suffusion of the eyelids. As far as my own observations have gone the premonition is invariably unilateral. If in addition to this sign there is considerable elevation of temperature the call for action is imperative.

Ligation of the angular vein can be easily carried out through a short incision carried down and slightly out from a point below the inner canthus along the junction of the nose and cheek. The angular vein is found lying in or under the fibers of the levator labii superioris alaeque nasi muscle. The operation is deserving of further trial in certain cases of infection that is progressing up the cheek and nose and whenever the presence of thrombophlebitis is suspected.

If frank pus is present in the upper lip drainage is usually advisable. Many pro-

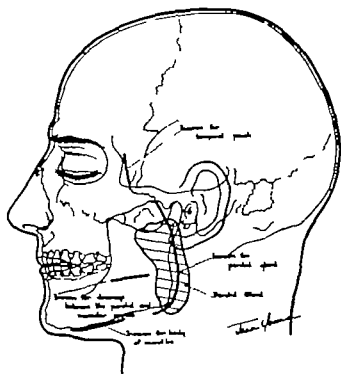


Fig. 8 Schematic drawing of the face with projection of the bony landmarks, showing the incisions for infections of the parotid gland and temporal spaces

cedures have been suggested but the gentle and ample opening of the abscess with a cautery knife and the removal of free sloughs seems to be simple, rational, and adequate. A general anesthesia should be used for any operation on the lip because local anesthesia tends to spread the infection already present. The incision in the lip should be made nearest to the area of broken down tissue, sometimes it can be made on the inside of the mouth, thereby avoiding a visible scar. Carp reports excellent results following the circuminjection of the patient's blood; others substantiate his claims. Our experience with this method is too small to carry weight.

Should the infection become generalized or meningitis supervene the treatment is that of these complications. The occurrence of thrombosis of the cavernous sinus must be suspected if swelling of the eyelids and exophthalmos appear. Paralysis of the ocular muscles usually is present early in the process. Within a few days the second eye becomes involved. Operative attack on cavernous sinus thrombosis has been suggested and undertaken with rather unsatisfactory results. After the infection has passed beyond the face to

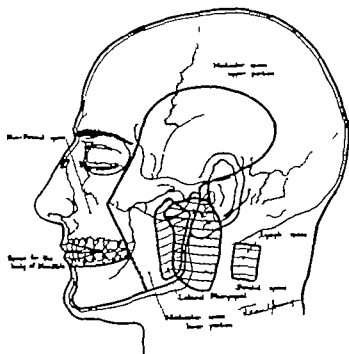


Fig. 9 Surface projection of the different anatomical spaces described.

the blood stream the prognosis is very grave and the result usually fatal. A comprehensive discussion of this is presented by Eagleton. It is possible that a satisfactory operative attack on the cavernous sinus may be devised but even this would not be applicable to many of the patients in whom meningitis and bacteremia are also present.

INFECTIONS OF THE LOWER LIP

Infections in the lower lip arising either in its external or internal aspect, are less serious than those of the upper lip. Cavernous sinus thrombosis seldom occurs secondary to infection of the lower lip because the veins of the lower lip lie at a deeper level and are more efficiently splinted by bone and muscle, and the lower lip is much less mobile than the upper lip. Infections arising on the inner aspect of the lower lip from the lower gingival border along the lower incisor teeth and in the floor of the mouth may pass along the lymphatics from this area to well defined spaces lying above and below the geniohyoid muscles (Figs. 12 and 13). The superficial space lies between the genioglossus and geniohyoid muscle. It is bounded laterally by the body of the mandible and is divided into 2 compartments by a median fascial septum. Another

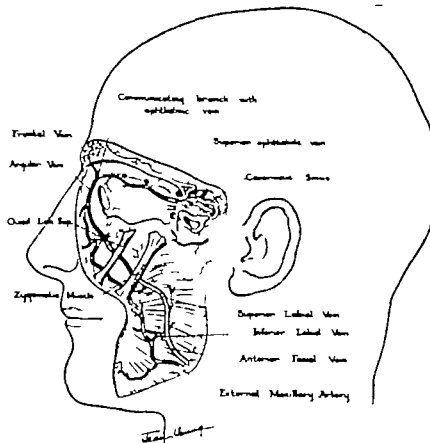


Fig. 6. Dissection showing the course of the anterior facial vein and its anastomosis with the superior ophthalmic vein (Adapted from Testut.)

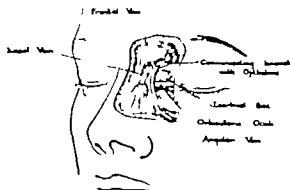


Fig. 7. Dissection of the region where the angular vein may be ligated.

space lies deeper between the geniohyoid and the mylohyoid muscles. This is also bounded laterally by the body of the mandible and divided in the middle by the same fascial septum. Another potential space that may be involved lies between the mucous membrane and the geniohyoid muscle in which lies the sublingual gland. Infection in the first mentioned areas gives rise to the clinical picture first described in 1836 by von Ludwig and still called Ludwig's angina.

Ludwig's angina. This infection gives rise to a clinical picture so constant and so severe that it has received much attention from surgeons. The diagnosis is made on the findings of an infectious process in the floor of the mouth in the spaces already described. There is an elevation of the tongue and redness and oedema of the mucous membrane over the



Fig. 12.

Fig. 12. Dissection showing sagittal section through median line in region of mouth showing spaces in the floor of the mouth. 1 Mylohyoid muscle 2 space between geniohyoid and mylohyoid muscles 3, geniohyoid muscle 4 space between geniohyoid and genioglossus muscles 5 genioglossus muscle (Courtesy Dr A. C. Furstenburg)



Fig. 14.

Fig. 14. External approach to spaces between the mylohyoid and geniohyoid muscles. (Courtesy Dr A. C. Furstenburg)

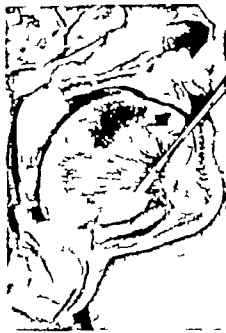


Fig. 15.

Fig. 15. Approach through mouth to the spaces between the geniohyoid and genioglossus muscles (Courtesy Dr A. C. Furstenburg)

involved area. The infection may be unilateral when the tongue is pushed to the opposite side, or it may be bilateral when it is pushed toward the roof of the mouth. The redness and edema of the mucous membrane of the floor of the mouth are marked, pressure of the swollen mucous membrane against the teeth often leaves an imprint. Discomfort is marked, swallowing is difficult, and speech becomes guttural. There is dribbling of saliva and the respirations become embarrassed. Dysphagia is not uncommon. There is a board like swelling externally in the anterior aspect of the neck. There is no point of fluctuation and although the infection may be limited at first soon it envelops the neck from side to side. The systemic reaction is often severe. Complications may arise from local or general extension of the infection.

Many papers have been written on the differential diagnosis of deep cellulitis of the neck and Ludwig's angina. It is highly probable that such a differential diagnosis is impossible since it is more than likely that there is no such original clinical entity as deep cellulitis of the neck. Infection always has a

definite origin and always spreads along certain planes. If neglected, infection may of course break through the anatomical barriers but originally it had definite boundaries and was a definite clinical entity.

The treatment of Ludwig's angina consists in early surgical drainage of the infected area. The technique of operation varies according



Fig. 13. Frontal section through mouth showing floor of mouth divided by median fascial septum indicated by crosses. (Courtesy Dr A. C. Furstenburg)

to the location of the infection which is not always easily determined. If the abscess is below the geniohyoid muscles the region under the chin is prominent and occasionally gives rise to fluctuation. An incision should be made through the skin subcutaneous tissue and mylohyoid muscle into the abscess cavity as shown in Figure 14 and drainage tube introduced. When the swelling is uniform the incision should follow the lower border of the mandible so as to give access to both sides of the median fascial septum inasmuch as one cannot always tell accurately from examination which side is involved.

If the abscess is located above the geniohyoid muscle it may point under the tongue and can be drained easily through the floor of the mouth, the incision passing through the mucous membrane and the genioglossus muscle as shown in Figure 15. The spaces on both sides must be explored. Blind exploration with a blunt instrument may fail to open a small abscess, but accurate dissection of the involved spaces usually will. When a neglected Ludwig's angina breaks through the walls of these spaces, it usually breaks into the lateral pharyngeal fossa with the signs, symptoms, and complications already discussed in connection with that space.

The anatomical studies of the fascial spaces that have been made by M. Paul Truffert of Paris and by Prof. E. Stincer of the University of Havana have been of exceptional value to us.

SUMMARY

1. Facial infections may spread by direct continuity or by the hematopoietic or lymphatic systems, or by a combination of these routes.

2. When the spread occurs by continuity its direction is determined by 3 fascial planes that enclose spaces which are anatomically described.

3. Infections in the mandible are usually limited by the so called mandibular space though extension may occur to the masticator space.

4. The masticator space may also become involved by infection of the zygoma and temporal bone. Methods of drainage of this space are considered.

5. Routes of spread of infection from supuration of the parotid gland and appropriate methods of drainage are discussed.

6. Infection of the upper lip and nose may cause thrombosis of the adjacent veins with resulting reversal of the venous flow. Infection or even thrombosis may then travel to the cavernous sinus. Infection of the lower lip may involve the spaces in the floor of the mouth and result in Ludwig's angina. This condition should first be treated conservatively but wide surgical drainage may become necessary.

BIBLIOGRAPHY

1. BAILEY, H. Ligation of the angular vein as a preventive measure in facial carbuncle. *Surg. Gynec. & Obst.* 1923, 46: 365.
2. BLAIR, VILRAY P. Septic parotitis. *Med. & Surg.* 1917, 3: 34.
3. BLAIR, V. P. and PARDETT, F. C. Pyogenic infections of the parotid glands and ducts. *Arch. Surg.* 1923, 7: 1.
4. BROWN, J. B., GROVE, E. W. and PITTMAN, J. E. Acute infections about the lips. *Inter. J. Orthodontia, Oral Surg. & Rad.* 1932, 18: 1212.
5. BULLOCK, W. O. Upper lip cellulitis: ligation of both facial veins three-fourths inch below inner canthus, recovery. *Surg. Gynec. & Obst.* 1912, 14: 156.
6. CAMP, LOUIS. Circumsection of autogenous blood in the treatment of carbuncles. *Arch. Surg.* 1917, 14: 868.
7. DERJARDINS, ARTHUR A. Radiotherapy for inflammatory conditions. *J. Am. M. Ass.* 1931, 96: 401.
8. EAGLETON, W. P. Cavernous sinus thrombophlebitis and allied septic and traumatic lesions of the basal venous sinuses. New York: The Macmillan Company, 1926.
9. HOMER, W. H., SNIFFERSON, H. and FAUST, C. L. Acute and chronic infections of the parotid gland. *Surg. Gynec. & Obst.* 1932, 54: 355.
10. RABBIT, F. W. and PALMER, B. M. Postoperative parotitis: treatment without and with radium. *Ann. Surg.* 1920, 72: 100.
11. ROEDER, C. A. Ligation of the angular vein in infection of the upper lip. *J. Am. M. Ass.* 1928, 90: 373.
12. SCHILLAU. Upper lip cellulitis: resection of anterior facial vein: recovery. *Soc. de Chir.*, 1912, p. 123.
13. STINCER, EMILIO. *Anatomotopografica Habana*, Cuba: Compania Impresora Industrial, 1924.
14. TRUFFERT, PAUL LE COQ. *Anatomie Topographique*. Paris: Librairie Louis Arnette, 1922.

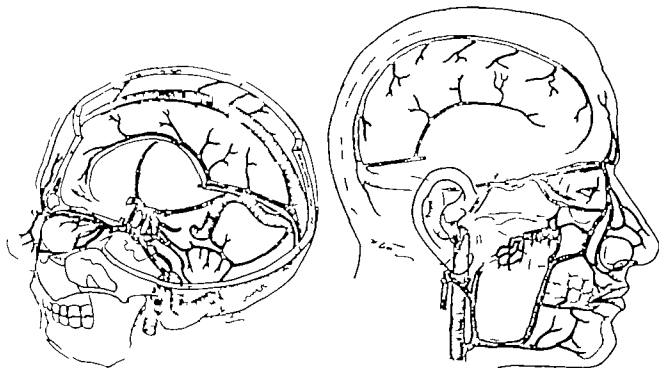
Discussion

DR. ELLIOTT C CUTLER, Boston Dr Collier has covered his topic in an admirable fashion and clearly indicated an important lesson for the surgeon. He has pointed out that in this field, as elsewhere the chief lesson tells us when not to indulge in surgery and points out that simple infections often need the greatest care and wisdom. This emphasizes the importance of so called minor surgery and the fact that such conditions need the advice and care of the senior members of hospital staffs and should not be delegated to junior assistants. Too often we see septic hands and infections of the face cared for as ambulatory dispensary cases until it is too late. Our distinguished past President Dr Allen Kanavel and his pupils have pointed to a great lesson in emphasizing the dangers of infections of the hand and how to care for them. Dr Collier makes a beginning for infections of the face the seriousness of which is often recognized too late.

In an attempt to further Dr Collier's lesson I shall consume my brief time in discussing *cavernous sinus thrombosis* a none too rare and usually fatal complication of infections about the lip and nose. The infrequency of reports concerning this condition indicates not so much the infrequency of the condition as its hopelessness. The very triviality of the original lesion often lulls both the physician and the surgeon into a false sense of security. Thus one of the patients in our Peter Bent Brigham Hospital series was a nurse. A small furuncle appeared at

the corner of her lip the patient opened this with a needle in 6 days she was dead with classical signs of cavernous sinus thrombosis. Another case in this series began as a simple pimple just below the eye. This rapidly became a carbuncle. After 4 days observation in the hospital and 13 days after the first pimple appeared excision with endothermy was carried out. The patient succumbed 6 days later with signs of disseminated sepsis including cavernous sinus thrombosis. A third case in the Brigham Hospital series was a member of the resident staff of a neighboring hospital, who acquired a small furuncle at the base of one hair in his mustache only 4 days before this lesion had spread to the whole lip and into the sinus and caused death. The fourth and fifth cases in my private series resulted from simple trauma. The first was a young boy struck by a baseball who suffered a small contusion of his malar prominence and the second was a little girl whose sister had slammed the door on her face giving her a similar tiny laceration over the malar prominence. Streptococci entered these small abrasions. Within a few days swollen eyelids, fixed eyeballs, choked disc, and stiffness of the neck ushered in the fatal result.

The danger of such a complication is visualized by a study of the anatomy of the parts and it is perhaps fitting that Dr Collier having emphasized fascial planes, I should emphasize the danger of blood vessel extension. The accompanying figures em-



Figs. 1 and 2 Note anastomosis at upper inner angle of eye between superficial vessels and the superior ophthalmic vein, and the connection between the deep pterygoid vessels and inferior ophthalmic vein. None of these veins has valves.

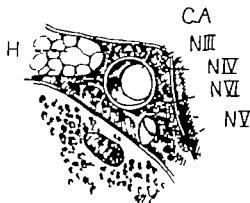


Fig. 3. Transverse view cavernous sinus. Note break up of sinus into innumerable contiguous compartments which greatly impede the flow of blood. Also note position of third, fourth, and sixth nerves and how easily disease of the sinus may affect them.

phasize the anatomical extension of the infection by way of blood vessels. The major peripheral orbital tributary of the cavernous sinus is the superior ophthalmic vein. This unites at the inner upper angle of the eye with the angular vein, the supra-orbital vessels, and the nasal vessels and other tributaries from the face and lip. But also there are fine anastomoses between facial vein branches and the inferior orbital vein, and deeper in communications exist between the pterygomaxillary veins and the cavernous sinus. Moreover none of these vessels carries valves and the flow of blood is slow and often reversed. Phlebitis of any of these superficial vessels may lead to extension into the cavernous sinus. We all recognize that trauma with injury of the intima, infection, and stasis play the major rôles when thrombosis results. For some good reason perhaps not well understood but possibly to prevent respiration from exerting too sudden an effect upon intracranial pressure, the cavernous sinus has a peculiar construction. It is cut up into many contiguous compartments which must greatly impede the flow of blood. This may be excellent for the purpose of buffering the intracranial tension against sudden shifts due to respiratory changes, but it also creates a most admirable condition for the extension of thrombophlebitis. When an infection is in the extremity we are not brought face to face with the great extension of thrombosis unless there be a resultant edema of the extremity or a

subsequent pulmonary embolus. But when the extension occurs into such an important anatomical part as the cavernous sinus, where the mechanical arrangement of the sinuses and the important structures lying near it call forth immediate clinical signs, then it early assumes an alarming picture. The danger of such an extending phlebitis in relation to the face has long been recognized and surgeons have learned to withhold mechanical intervention wherever possible. Surgery, by opening into vessels beyond the natural "walling-off" process, may permit bacteria to enter tributaries draining into the sinus. As cavernous sinus thrombosis progresses, the extra-ocular muscles become paralyzed by involvement of the nerves lying in the sheath of the sinus, vision is lost from thrombosis of the ophthalmic vein, and this is preceded by an ominous choked disc.

There is no suitable therapy for cavernous sinus thrombosis, though one finds occasional reports of cases where almost superhuman surgery has seemed to save a life. Thus there is a report by Browder of Brooklyn¹ telling how, in the face of seemingly definite thrombosis of the cavernous sinus on one side, he opened the cranium and completely obliterated the cavernous sinus on the affected side by the use of electrocoagulation. This apparently stopped the progress of the infection and, though his patient lost the eye, life was saved. A similar extensive procedure has been proposed by Eagleston² recently, the approach to the sinus being through the eye. This author also reports successful cases. Less radical surgery has on the whole proved meddlesome and costly. In a series of 23 cases treated in the wards of the Peter Bent Brigham Hospital for serious infections of the lip, nose or cheek—either carbuncle or cellulitis—there was a mortality of 30.4 per cent. In 10 of these cases some simple surgical procedure was carried out. In this group the mortality was 50 per cent against 21.7 per cent in the untreated group. And a study of the records showed no great difference in the cases.

Prevention of such a complication is what we most desire and in view of the anatomical considerations it seems wisest to urge conservatism for the moment in the treatment of spreading infections, arising in the lip, nose or close to the eye particularly if the streptococcus is the etiological agent. Such conservative treatment will consist of heat to the local part and general care to the patient.

¹Browder, E. Jefferson. Carbuncle of nose, ophthalmic vein phlebitis, opening for cavernous sinus thrombosis, recovery. Report of case. *The Laryngoscope*, 31:3, Dec., 1920-21.

²Eagleston, W. L. P. Cavernous sinus thrombophlebitis. New York: The Macmillan Co., 1926.

³Campbell, Edward R. The cavernous sinus: anatomical and clinical considerations. *Ann. Otol. Rhinol. & Laryngol.* 31:3, 43-51-43.

EXPERIENCES WITH TUBED PEDICLE FLAPS¹

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A TUBED pedicle flap is a type of delayed flap in the form of a tube in which the long edges are sewed together. It is thus completely separated from its bed except at the two attached ends and is not replaced, as is a delayed flap. As for all types of delayed flap the object of the procedure is to induce a blood supply parallel to the long axis of the flap. The tubed flap is different from the other forms of delayed flap in that it prevents any form of granulation or scar tissue formation on its deep surface.

It was first described by Filatoff in 1917 (1), but the idea occurred to me quite independently in the same year (3). Its immense usefulness was immediately recognized by my colleagues in the War at Sidcup. It has since undergone many modifications and its field of usefulness has been extended. In the process its limitations have also been more accurately defined (4).

GENERAL CONSIDERATIONS

The rationale of the flap is to increase its longitudinal blood supply at the expense of the transverse so that it can survive on the blood supply of one end only. The idea is by no means new and the original Tagliacozzi (6) operation was a simple delayed flap. Other forms of delayed flap tend to produce considerable contraction from granulation tissue on the deep surface. The time factor is also different from that of the usual delayed flap as in my own experience I seldom if ever, trust the blood supply at one end of the flap until a minimum interval of 3 weeks. Lymph stasis in the flap is also one to which consideration should be paid some of the "tubes" undoubtedly show this condition and if so they can be left a further interval of time until the lymphatic circulation is established, their subsequent success as regards viability, adaptability and cosmetic effect is considerably enhanced. In a long established tubed

pedicle, which has had many removes great liberties can be taken with its blood supply

ADVANTAGES

Its chief advantage lies in the readiness and safety with which large quantities of skin may be transported from a distance. The tubed pedicle having been successfully made its size can be increased either laterally or longitudinally so that huge quantities of skin can safely be transplanted. It is of particular use where no massive direct flap is available such as is usually used when body skin is transferred directly to the arm or forearm. Another of the characteristics of a tubed pedicle is that when once established its flexibility allows it to be twisted and turned in the most liberal manner without causing anxiety as to its viability. It lends itself to temporary attachment through an intermediate host.

When the wrist is used as a means of conveying a large abdominal tubed pedicle flap one has given it an additional mobile pedicle whose base may now be considered to be at the shoulder. The flap can therefore be carried to any position of the body from the sole of the foot to the crown of the head or to any intermediate portion. The use of the wrist as an intermediate host is a great step in advance over the caterpillar method. Its viability has already been stressed. As a cosmetic flap it is at least up to the standard of any other type of flap except in one or two specific restorations.

DISADVANTAGES

The chief disadvantage is the time factor which includes the financial aspect. For example, the shortest time that an abdominal flap can be transported to the neck works out in practice as shown in Table I.

Factors increasing the time. When flaps larger than say 8 by 3 inches are required or when there are branch extensions of the flap some provision must be made for safeguarding the blood supply of these elongated masses such

¹Presented before the Clinical Congress of the American College of Surgeons Boston October 19-20 1934.

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Fig. 1 Tubed pedicle flap for nose. Direct application. Upper lip, eyelids, and eyebrows also grafted.

as making these tubed pedicles by stages, undermining, delaying or partial division of

TABLE I—TIME INTERVAL. ABDOMEN—WRIST—NECK TRANSPLANTS

- First Operation
The making of the pedicle followed by
Interval 3 weeks
- Second Operation
Transfer one end to wrist followed by
Interval 3 weeks
- Third Operation
Detachment of other end from abdomen,
half opening out of pedicle flap and
transfer of this half to the neck fol-
lowed by
Interval 14 to 21 days
- Fourth Operation
Separation from wrist and spreading out
into the neck of the balance of the
flap
Total time average 12 weeks

The whole of this time need not and should not be spent in hospital

the end of the pedicle that is about to be moved. Further the wrist is frequently inserted into the middle of the flap rather than to one of its extremities, in order that the blood supply can flow equally to either end. All these minor variations require extra time and extra operation stages. The financial outlook therefore both for patient and surgeon is not a rosy one. The time factor required from the



Fig. 3 Branched tubed pedicle for face—long acromioclavicular type. Replacement of whole chin, upper lip, and the whole of the left cheek. Separate nasal reconstruction. b Branch pedicle for upper lip hidden behind pedicle.



Fig 3 a, Iliac bone graft for mandible first grafted beneath extremity of tubed pedicle b, Conveyance to mandible c, Final result d, Roentgenogram showing bone graft in position

surgeon is also serious as experience shows that to hustle any of the stages leads inevitably to an eventual delay or disappointment. Many stages, however, can quite adequately be performed by a well trained junior.

The other disadvantages of the flap are connected, in my opinion with failure of the operator to observe the principles of technique, thus he may shorten the interval he may misjudge the viability of the flap, he may sew it up too tightly or in some other way interfere with its blood supply. If he fails to remove the

fibrous tissue in the unrolling process, full functional cosmetic success will not be obtained. Disappointments may also occur owing to a faulty plan in the first place.

If, however the technique has been carefully observed, both patient and surgeon will have a pleasant surprise in finding that the flap fits and looks well in its new bed.

TECHNICAL DETAILS

The plan. As I have stressed many times an accurate diagnosis of the loss of skin should



FIG. 4. Excision of jaw and soft tissues of chin and lip by Mr. Gordon Taylor (London). Plastic repair by double

crossed tubed pedicles. Bone graft and trimming. Unflexed

first be made. Due allowance should be included in this estimate for the retraction or replacement of normal tissues into their normal position when the scar has been excised. Many experienced operators frequently fail to realize the full extent of the loss. A great help can be obtained in this diagnosis, as in any other, by comparing the sound with the unsound side of the body or comparing the damaged part with a normal one. A model is now made of the exact loss in sterilizable material. I have published recently a technique for design of direct flaps which will be found eminently suitable for the tubed pedicle variety (5).

It is as well to cut the flap very slightly on the liberal side so as to allow for a final excision of its margins, also for the ease of adaptation in certain situations an extra length of pedicle should be added to the flap proper.

Some rules as to judgment of the proportion of these flaps must be given. Thus a flap that was 8 inches long and only 1 inch broad would, in my opinion, be dangerous to make at one sitting. Any flap of longer than 8 inches of any width should not be made at a single venture. There enters the problem of the actual vitality of the skin of the patient under consideration. This is a factor in which only experience can assist in the decision.

Incisions. Parallel incisions to the extent designed are made through the skin and subcutaneous tissues. Again judgment must come into play as to the amount of fat to be included both as regards the restoration required and the presence or absence of a large quantity of subcutaneous fat. In spare

subjects, for instance, the incision can be carried down to the subcutaneous fascia with advantage to the visibility of the flap and to the rapidity and ease of its manipulation. In a fat subject however the inclusion of such a quantity would be deleterious to the final result and would make the future of the flap a matter of some difficulty and be of considerable immediate peril to its blood supply. A thought occurs to me in regard to blood supply in fat patients that there is only a limited quantity of blood supply to an individual area, which in the presence of the fat is dissipated before it enters the skin. Consequently in obese subjects I would issue this note of warning to be more patiently conservative than in the thin. The length of the primary tubing can also be varied according to the actual site from which the flap has been taken. Thus a flap in the oblique inguinal region or one more vertically parallel to the main vessels of the abdominal wall can be cut with a greater margin of safety than one which crosses the middle line either above or below the umbilicus, or traverses the middle line of the chest. Flaps whose base lies in the region of a natural anastomosis such as the acromial can, therefore, be cut with confidence.

Sites. The common donor sites are the oblique inguinal single or double, the vertical abdominal, the acromiopectoral single or double, the less common sites are the neck, the back of the shoulder, the outer aspect of the arm and the outer and anterior aspects of the thigh.

Suture. As the skin edges are rolled together there is a tendency for fat to protrude. It



Fig. 5 Example of branched pedicle. The branch is for the upper lip, the extremity for the nose, and the neck portion for the cheek





Fig 6 Example of one pedicle flap (temporal artery) conveying another tubed pedicle (acromial) to the nose

should be trimmed with scissors and as the suture progresses the action of the thumb in advance of the suture will effectually prevent the interpolation of fat between the skin edges. After the flap has been cut and its undersurface carefully examined for bleeding points, a decision is made as to how much of the flap can be tubed without undue tension at either end. A fine hook is passed through the skin at the commencing point and the skin of that side dragged through into juxtaposition with the corresponding point on the near side. A first interrupted suture is placed



Fig 8 Acromiopectoral flap—special method for nose. Upper right photograph shows acromial end of pedicle attached to palmar aspect of wrist



Fig 7 a, Transference of abdominal tubed pedicle to neck via the wrist. Typical method. b, The first implant

to the neck. c, The new neck, with an extra piece let into the chin to cure the drag of the mouth



Fig 9. a Severe burn of half the face. b Restoration by abdominal tubed pedicle. c, Double temporary attachment to wrist for convalescent purposes. d, Artificial eye-socket on glasses.



Fig 10. Bilateral abdominal pedicle with central attachment to wrist. The opportunity was taken of implanting this pedicle into a scar which was present at the base of the thumb.

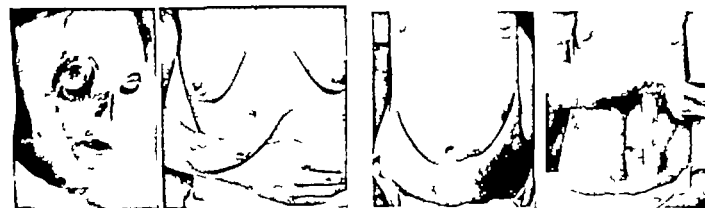


Fig 11. Example of vertical abdominal pedicle including the umbilicus for whole face replacement.

and held as a stay. A similar procedure is adopted at the other end. The two edges of skin are now presented to the operator and may be sutured with ease. If the flap is to be used in an exposed position it is well to make this suture with a subcuticular stitch, using an eyeless needle. At all times avoid damaging the skin with dissecting forceps.



Fig 12. Bilateral abdominal pedicle for avulsion of scalp. Implantation of both extremities to back of wrist.

Closure of the secondary wound. A decision now has to be made as to whether the wound can be closed by direct approximation beneath the pedicle or not, such a closure is usually available in the abdominal wounds as well as in the acromiopectoral. Free undermining of the surrounding skin and positioning of the thigh or the arm will materially aid this clo-



Fig. 13. a, Laceration extending from the upper arm to below the elbow. b, Repair of inner aspect of arm by direct flap. Note the tubed pedicle extension thereof. c, Showing part

of direct flap. d, Showing use of tubed pedicle to form elbow skin. Razor graft being used for the outer aspect of the arm.



Fig. 14. A huge tubed pedicle flap from outer aspect of buttock and thigh (make skin clothing for damaged leg).

sure. Deep catgut sutures relieve the tension and interrupted silkworm sutures are placed through the skin.

At the place where the tubed pedicle leaves the abdomen, at either end will now be found a triangular raw area. There will likewise be found a similar raw area in the abdominal wound. The apices of the two triangles are approximated by a special suture. The needle is passed through the skin of one side of the abdominal edge, emerging in the subcuticular area. It is continued as a subcuticular stitch first down one side and then up the other of the apex of the tubed pedicle triangle. Finally it emerges opposite its entrance at the apex of the abdominal triangle. When tied, the two triangles are accurately approximated. When there is no possibility of a satisfactory secondary closure the raw area may be left

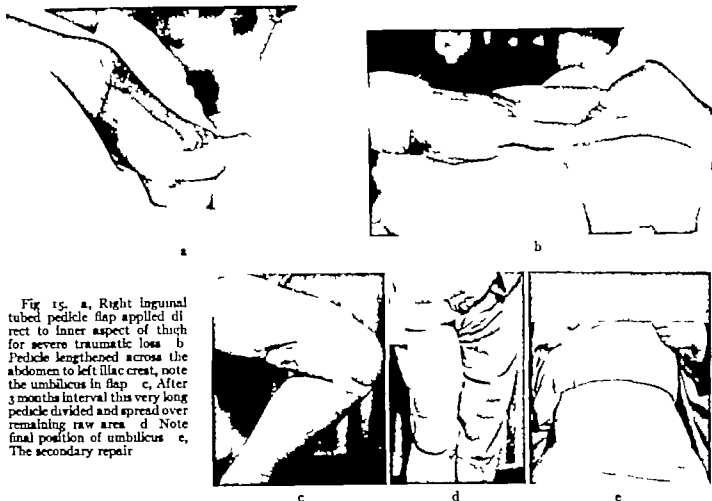


Fig. 15. a, Right inguinal tubed pedicle flap applied direct to inner aspect of thigh for severe traumatic loss. b, Pedicle lengthened across the abdomen to left iliac crest, note the umbilicus in flap. c, After 3 months interval this very long pedicle divided and spread over remaining raw area. d, Note final position of umbilicus. e, The secondary repair.

to granulate or be grafted with a free razor graft.

There are certain modifications of technique for *very large* or *very broad* flaps. The size of the amount that may be tubed at the first intervention has already been indicated. If further skin is required the tubing process may be continued at the end of 10 days to a fortnight. The same remarks apply on the occasions when a branch tube is run sideways from the main tube. When the flap is very broad it may frequently be found advisable to make a square-ended implantation into the forearm as the first stage and to follow this up by tubing the broad flap 14 days later.

Dressing Further to safeguard the secondary closure the skin is treated with mastisol and gauze applied from side to side beneath the pedicle. Two gauze rolls are now placed parallel to the tubed pedicle to safeguard it from any undue pressure and yet to allow of inspection for the presence of hæmatoma or the progress of the circulation.

A pedicle should be examined the same evening and at frequent stages. Any hæmatoma should be freely expressed and if the vitality of the flap be endangered for any reason warm saline dressings should be applied at very frequent intervals. At all stages massage of the flap is of considerable value.

THE FIRST REMOVE

For a simple pedicle of not more than 8 inches it should be possible to detach one end after an interval of 3 weeks. This time will have to be increased if there has been any hitch or if the pedicle is of greater dimension. In severing the end designed to be moved first, care must be taken not to include any considerable portion of skin which was not tubed in the first instance and is therefore devoid of an already established longitudinal blood supply. If insufficient of the flap has been "tubed" at the first occasion the extra bit must either be "delayed" or further "tubed" prior to its being cut off. The raw



Fig. 6 Use of thigh as intermediate host for transference of abdominal pedicle to opposite leg

end of the pedicle is now free in the air and is approximated to its next home. When the process is direct such as in an acromiopectoral flap to the cheek or nose just so much of the pedicle is opened out as is convenient for the restoration or safe from a blood supply point of view. For instance, it is not usually safe to open a pedicle more than half its length. When the free end of the pedicle is to be grafted into an intermediate host as the wrist, very little of the pedicle need be opened out say 1 inch.

The opening out process. The pedicle flap is held in the hand with the seam uppermost and the extremity of the raw area retracted with fine hooks by an assistant. The seam being kept central a fine knife is used to excise or incise this seam until the pedicle opens out. It is essential that the opening out of the pedicle should be done on the same line as that in which it was closed.

The blood mark. A convenient method of design for implanting the open end of the

pedicle is by squeezing it, say on the back of the wrist to which it is to be attached. This makes a blood mark of the exact size of the raw area of the pedicle. If now half of this blood mark be turned backward toward the pedicle the two areas when sutured together should be approximately equal. Again care must be taken to prevent hematoma formation. In addition to tying the vessels, it is as well to put in two deep catgut sutures to approximate the fat of the two areas. Care, even in this maneuver must be taken also for I have known quite a number of cases in which their presence has constricted the blood supply to part of the flap. Suture of the skin edges of this stage is usually by interrupted, occasionally by blanket method.

SECOND REMOVE

The second of the two original attachments of the flap is now divided. If the pedicle be of reasonable proportion that end of the flap



Fig. 17 Neck pedicle including active platysma lifting a weight by voluntary contraction.

may be divided in a similar manner to the first, but if unduly large or not fully 'tubed' the extra precautions noted before must be taken. The interval of time between the first and second remove must not be less than 3 weeks before final division. In a simple case by the direct method from the acromial region, a pedicle can be carefully opened by excising its little joining scar, and the whole flap embedded into its final position. More commonly it is wise not to open the whole of the pedicle at this stage but to leave some minor adjustments for a future occasion. When an intermediate host has been used the second remove corresponds in all particulars to the first by the direct method while the third after an interval of 2 to 3 weeks is carried out similarly to the final stage of the direct. Should there be for any reason any long delay say 2 or 3 months in between any of the stages the subsequent maneuvers will be all the easier.

Variations When the patient is in no hurry and finds the fixation of his arm to the abdomen irksome at the end of the second stage instead of bringing the free end of the pedicle up to the neck or face it may be implanted into the forearm alongside its fellow, where it can rest happily to await the return of the patient or perhaps the surgeon from a holiday. When the pedicle is very large bilateral, or has a branch pedicle attached, it will be found convenient to attach the wrist to the opened out middle portion of the pedicle. This



Fig. 18 Example of central necrosis due partly to crossing mid abdominal line

enables the blood supply from the wrist to wander evenly through to the extremities of the pedicle, and when such a pedicle is taken say to the neck two free ends are available attached by their middle to the wrist. The free ends are therefore sewed to the back of the neck and the final stage made when the wrist is detached from the middle of the pedicle. Warning must here be given that in such a central attachment of the pedicle to the wrist, the implantation must be very near the wrist joint or back of hand if that pedicle is going to be used for the neck (see Fig. 10). If the center of the pedicle is allowed to be attached further up the forearm a number of troublesome complications are likely to occur.

A broad attachment of the pedicle to the radial border of the forearm is indicated only in cases of repair of one side of the face above the mandible.

EXPERIENCES COMMON AND UNCOMMON

Tubed pedicle flaps have been used by me for the successful closure of a pharyngeal fistula to form the outer covering for hypospadias repair for the repair of the penis after phagedenic ulceration and after accidental avulsion of its skin, for vesicovaginal fistule, and by other surgeons for other unusual conditions. I have designed a tubed pedicle for remaking of a breast after amputation. In one tubed pedicle of the neck I included the platysma muscle with its nerve supply intact. The curious phenomenon of this patient being able to raise a weight by voluntary contraction of the pedicle is an interesting study. Branch pedicles have been used either direct

acromipectoral or abdominal via the wrist for such conditions as both sides of the scalp and forehead the forehead and nose the cheek and chin or the cheek and upper lip and for a complete neck. On three occasions pedicles have been implanted into another pedicle as its intermediate host a particularly good one being the turned down temporal artery flap attached to an acromial. A most remarkable study in viability of these flaps occurred in a case in which two long pedicles were joined end to end. When one end was finally detached the circulation from the upper end of the first pedicle was entirely adequate to penetrate through a very poor joining scar right to the extremity of the second pedicle. It is found convenient occasionally to cross-cross two pedicles or to cross over the free ends of a long pedicle. These maneuvers are dictated by expediency and opportunism. A special method of making the nose from an acromipectoral flap is to detach the acromial end and to suture it to the palmar aspect of the opposite wrist in such a way that when the back of the hand is placed on the forehead the pedicle will be hanging straight down the nose with its

joining seam facing backward. Examples could also be enumerated of transferring the pedicle via the wrist to the knee or lower and of using the opposite thigh as an intermediate host for areas below the knee. One of the longest pedicles I have ever made went from side to side of the abdomen including the umbilicus. It was tubed in two stages, the second stage after the first implantation had been successfully grafted into the thigh. After the second half had been tubed the flap extended from the region of the inner condyle of the right femur to the left iliac crest about two-thirds of it being in the air. The umbilicus was seen to adorn its middle and eventually to end up somewhere above the knee, an unusual place in which to carry the navel.

REFERENCES

- FILATOFF W. *Plastic a tige ronde*. Westark Oftalmol 1917, April, May, Nos. 4, 5 (russie)
- 1 Idem. *Operations plastiques a tige ronde ambulatoire*. Presse med 1923, Dec 19 p. 661
- 3 GILLIES, H. D. *Surg. Gynec. & Obst.*, 1930, 20, 131
- 4 Idem. *Plastic Surgery of the Face*. London: Oxford University Press, 1930
- 5 Idem. *Brit. M. J.* 1932 Dec. 3
- 6 TAGLIAZZINI, GASTAR. *De Cartotom Chirurgical per Insurrectionem*. 597

Discussion

DR. CHARLES G. MINTER, Boston. We are all doubtless familiar with Sir Harold Gillies' work in plastic surgery. His accomplishments in reconstruction of severe facial injuries was one of the outstanding contributions of the War. It was he who popularized the transference of large areas of skin obtained from distant locations by the tube graft method and placed it in the hands of the profession as a most useful procedure. Formerly in my service at the Children's Hospital I had an opportunity of using this method freely and with satisfaction, chiefly in the correction of deformities following burns. In large part these deformities occurred in girls due to the inflammable nature of their dresses. Contractures of the extremities, aniles and in particular the neck, have yielded eminently satisfactory results under this method. In late years, the better understanding of the Z method of utilizing the scar tissue web has, to an extent, supplanted the tube graft but in broad contracted contractures the latter is the method of choice. In my opinion.

The use of the tube graft has not been invariably successful in my hands. Ischemia is the most potent cause of failure. Too great length in comparison to the width of the rectangular flap raised for construction of the tube, too tight suture about the enfolded

subcutaneous tissue and too early transference of one end to its new location are among the causes of diminished blood supply.

In my experience, relief of the broad contracting scars of the neck following burns is most satisfactorily obtained by the tube graft method. The lesson usually occurs in girls and the choice of site from which to make the transfer with a minimum of visible scarring is difficult, as no one can forget how far the present trend in feminine fashions may ultimately lead its votaries. The lower lateral aspect of the chest wall seems the most suitable situation.

In conclusion I should like to express to Sir Harold our sincere appreciation of his brilliant work in this field and thank him for his kindness in presenting his views on the subject tonight.

ERNEST M. DALAND, M.D., Boston. The development of the tube pedicle graft has solved many plastic problems. The speaker has been too modest in regard to his part in the origin and development of this method. It is he who has put it into practice and he who has had the courage to try out new applications for its use.

In selecting a site for the graft it is essential to remember whether the skin used is going to grow hair

or not. If the graft is going to become a lining for a cheek, it is essential that there be no hair on it. If the graft is to form a covering for a man's cheek it is desirable that there should be hair on it.

Most of us have had cases in which we have used the tube pedicle graft successfully. Some of us have had failures. I wish to point out some of the reasons for these failures.

1 The tube has been made too long in proportion to its width. Sir Harold sets 8 inches for the maximum length but then only if conditions are ideal. If not a full 3 inches of width is available, the length must be less than 8 inches.

2 The tube graft has been too narrow.

3 Too much fat has been used in the flap. The tube edges should come together without tension. Too much fat will cause eversion of the skin edges. The secondary swelling and lymph stasis will shut off the circulation and the flap will die.

4. Too little fat in the flap will likewise cause trouble. In a patient with no subcutaneous fat, the pedicle method is probably not the best.

5 The flap has been cut too close to the midline or has crossed over the midline. Occasionally a flap may be constructed that crosses the midline but it should be made slowly and not made too long at the first stage.

6 Infection will produce necrosis and scarring and interfere with the circulation.

7 The dressing may be applied too tight over the tube pedicle flap. This may cause thrombosis and necrosis.

8 The transfer of the flap may be made too early. Three weeks is usually early enough, unless the flap is very short.

9 Finally, in moving the graft to its new position I find that tissue that has been heavily irradiated makes a very poor host. In fighting the irradiation reaction, all the collateral circulation has been called on. As a result, little circulation goes into the graft and healing, if it occurs at all, is delayed.

If a few of these precautions are followed I am sure that we shall all be satisfied with the results which we obtain.

PHAGEDENIC ULCERATION—ITS RECOGNITION AND TREATMENT¹

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From the Department of Surgery Stanford University Medical School

Phage dévora, cancer Phageo to eat

SINCE Cullen's arresting description of his experience with a particularly stubborn infection following incision of an abdominal wall abscess, presumably appendiceal in origin, numerous similar experiences have been frankly and courageously recounted by perhaps somewhat chastened surgeons. The picture is much the same in each instance following drainage of an abscess, whether of the abdomen or chest (Fig. 1) there has occurred a slowly but insidiously progressive destruction of the skin before which the surgeon has for a time stood completely helpless, baffled because none of the usual and known bactericidal agents—chemical or physical—seemed to have the slightest influence in controlling the infection and served only to strike terror to the patient through their extreme painfulness. No other experience is calculated to be so effectively humiliating nor likely to fill one with a greater sense of futility as to see the precious covering of the body in spite of anything one may do slowly but surely recede before the relentless advance of invading organisms. They seem literally to eat away the skin. The disease is characterized by a remarkable chronicity. Until its final stages it is not fulminating nor unusually prostrating following the development and drainage of the initial infection. It is usually not attended by severe constitutional symptoms. But inexorable in its advance and apparently inevitably progressive it is completely demoralizing to a patient who in full possession of all his faculties, is subconsciously aware of the helplessness that weighs heavily upon his attending physician. Ordinarily nature is very kind in dulling the sensorium of the acutely and gravely ill patient so that little remembrance remains of a particularly trying period. In this disease the patient shares the apprehension of the doctor and too often his morale is completely broken. He awaits the dressing with terror and begs to be let alone.

He prefers death to the harrowing experience of the daily dressings. Fortunately Cullen's opportune rediscovery of the cautery and Baer's courageous application of maggots in combating stubborn infections have provided a very satisfactory way out. The problem is to recognize the lesion and to apply the proper therapy at the right time.

An analysis of the recorded cases reveals some instructive facts. By far the greater number have followed the drainage of intra-abdominal abscesses usually appendiceal in origin. The accompanying table (Table I) presents a brief résumé of the recorded experiences. Sixteen cases followed the draining of a ruptured appendix, one case followed a caecostomy for carcinoma of the sigmoid, another followed drainage of a subphrenic abscess complicating a perforated duodenal ulcer, another followed drainage of an encapsulated empyema complicating appendectomy with drainage, another followed drainage of an empyema complicating a pulmonary abscess, one case followed drainage of an empyema complicating pneumonia, one case followed the draining of an abscess of the breast, and one case followed an infection of the abdominal wall in a gardener subject to contact with organisms found in the soil and in fertilizers.

The last named case deserves more comprehensive comment. Luckett in 1909 advocated and performed cautery excision for a spreading phagedenic ulceration of the abdominal wall. The patient was a gardener who had picked a small pustule with his fingernail within 10 days an ulcer $5\frac{1}{2}$ by $10\frac{1}{2}$ inches had developed over the abdomen with astonishing rapidity and much pain. Excision of the edges by the Paquelin cautery was followed by prompt healing. The cultures yielded only a *Staphylococcus aureus* both in the aerobic and anaerobic cultures. The hospital pathologist Dr. Humphreys made the fol-



Fig. 1. Remarkable progressive ulceration of thoracic wall following drainage of empyema complicating a pulmonary abscess (Christopher)

lowing arresting suggestions "In my opinion the infection probably belongs to the heterogeneous class known as soil or dirt infection to which belongs chancroid phagedena malignant oedema etc. The organisms of this class in general are anaerobic spore bearers inhabiting rich soil etc. Owing to the difficulties of artificial cultivation their specific characters are but little known. The staphylococci are probably of only secondary significance."

The following 4 cases are added to this growing list of experiences with a slowly but irresistibly advancing infection which as yet remains somewhat obscure in its origin which is peculiarly resistant to all forms of therapy but which yields to cauterizing débridement, when applicable and to maggot therapy

CASE 1. M. S. aged 25 a single female while working in a garden in December 1930, developed a blood blister on the palm of the left hand. The

blister was opened but was not dressed, and she continued her work with fertilizers and soil without protection of the wound. This healed after temporary soreness but 2 months later a tender mass appeared in the left axilla which was incised and drained on February 6 1931. The culture is said to have yielded a streptococcus. Due to non healing a second incision was made in April for the evacuation of pus and the removal of necrotic gland tissue.

The discharge of pus continued however and the wound instead of improving grew larger. When first seen on July 21 1931 8 months after the beginning of trouble there was a dirty looking wound about 6 by 4 centimeters with an abscess cavity leading up underneath the pectoral muscle toward the apex of the axilla. The 2 incisions made 3 and 5 months previously were unhealed and discharging pus. The edges of the wound were distressingly painful to all the known antiseptics most of which had been given a trial and found ineffectual.

Direct sunlight irrigation with 5 per cent salt solution, and the occasional application of Berwick's dye during the next 2 months caused slight but definite improvement. Slow progress prompted admission to the hospital on September 15 1931. At this time the red cells numbered 4 180 000

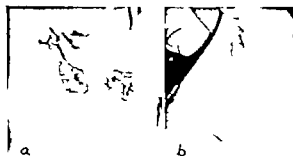


Fig. 2. December 9, 1931. Appearance of axillary wound 1 month after incision of abscess. Note the progressive ulceration below the incision and the secondary ulceration posteriorly. b. October 4, 1932. Complete healing without fibrous contraction.

hemoglobin, 95 per cent and the white cells 13 600 of which 70 per cent were polymorphs, 12 per cent lymphocytes and 8 per cent large mononuclears.

Cultures on October 12 from the original wound disclosed a pure growth of hemolytic streptococci.

Under observation an instructive development occurred. Below and posterior to the original wound, in an area bathed by pus, there appeared a small pustule which looked like an ordinary hair follicle infection. After discharging a central slough or core, the resulting wound spread slowly but insidiously through a gradual necrosis of the wound edge until it was 3 centimeters in diameter. Subsequent cultures showed in addition to the hemolytic streptococci, the presence of the *Staphylococcus aureus* and a non-virulent diphtheroid bacillus. Special cultures from beneath the undermined skin established the absence of anaerobes.

During a 6 weeks' stay in the hospital, the treatment consisted of forced nourishment, rich in vitamins; irrigation with hypertonic salt solution and the daily exposure to the quartz lamp. For a few days on one occasion, an erythematous blush spread forward from the wound over the left breast but subsided rather promptly. The administration of 50 cubic centimeters of anti streptococcus serum produced a violent reaction at site of injection in the left thigh but no sloughing occurred as in the Arthus phenomenon. Following her discharge from the hospital on October 26, 1931, the patient underwent treatment of the wound with a bacteriophage for 8 weeks without improvement.

The patient was readmitted on December 18, 1931, for the purpose of undergoing treatment with maggots. In the meantime the 2 wounds had spread slowly but gradually through an advancing necrosis of the skin edge (Fig. 2). The denuded surface was covered with a dirty looking pus, the edges were slightly raised, infiltrated and firm, undermined for about 4 millimeters and of a dusky bluish discoloration fading through red into the normal color about 1 centimeter from the edge. There was no macroscopical gangrene or necrosis.

One thousand maggots were introduced into the wounds on December 19, 1931 and a second lot of 1,000 on December 24. These caused a violent reaction in the tissues, as shown by marked edema and considerable purulent discharge. The temperature rose to 40 degrees C and liberal doses of penton, alternating with sodium amylal, were necessary to keep the patient comfortable. The violent reaction in the wounds, the high fever and the great discomfort prompted removal of maggots on December 26. The edema and fever promptly subsided and the wounds showed marked improvement.

On December 31, 1,000 maggots were again introduced into the wounds, but removed on January 3. The patient was dismissed on January 6 the wounds looking very much improved.

On March 7 the patient was re-admitted because of the persistence of a deep axillary wound. The superficial ulceration posterior to the axillary wound was healed. One thousand maggots were introduced into the axillary wound on March 7 and removed on March 11. Temperature rose to 39 degrees C but dropped promptly on removal of the maggots. The patient was discharged on March 12 and re-admitted on April 16 for the fifth and last introduction of maggots. On July 18, 10 months after the inception of the infection, she reported for observation completely healed.

On September 23 the patient re-entered the hospital for a brawny induration of the axillary scar which had followed overexertion of that arm in a tennis game. An abscess broke spontaneously from which both the *Staphylococcus aureus* and the hemolytic streptococcus were recovered. Prompt healing occurred after evacuation of the abscess.

On January 16, 1933, the patient re-entered the hospital for an exactly similar reaction in the scar following heavy work in the garden. An abscess was incised which again yielded both *Staphylococcus aureus* and hemolytic streptococci. Complete healing followed, and no further trouble has developed.

An axillary abscess followed a small blister of the left hand which had been opened and exposed to animal fertilizer. In the original culture only the hemolytic streptococcus was recovered. After 11 months of progressive enlargement of the axillary wound and the development of a secondary ulceration of the chest wall, from which the hemolytic streptococcus and the *Staphylococcus aureus* were recovered, the wounds were treated by the introduction of maggots on 5 occasions in a period of 4 months. Healing was not complete until 19 months after the initial lesion had occurred.

On two subsequent occasions 2 and 6 months after complete healing had occurred,



Fig 3 a September 3 1932 Progressive ulceration of abdominal wall following simple appendectomy 10 months previously Note undermining of vulva b April 26, 1933. Re-epithelialization of abdomen by successive skin grafting following cauterization of ulceration Granulating areas still present in both inguinal regions involving femoral vessels. x Site of erosion of left femoral artery y Site of incision for ligation of external iliac artery on April 3 1933

the trauma of effort initiated an abscess in the healed scar, from which organisms were obtained exactly similar to those presumably responsible for the initial lesion. In spite of the presence of both these organisms healing occurred without delay following evacuation of the abscess.

CASE 2: M W aged 42, housewife was operated upon February 6 1931 for a fixed pelvic mass, which was found to be an ectopic kidney. An appendectomy was performed through a lower midline incision. This incision broke down the edges became undermined, and despite numerous and varied forms of treatment, a gradually increasing ulceration of the abdominal wall developed. This treatment included irrigation with hypertonic salt solution, Dakin's solution, hydrogen peroxide, mercuriochrome, the administration of potassium iodide and salvarsan, the use of the quartz lamp sun baths, a staphylococcus-streptococcus bacteriophage maggot in the wound, transfusion from an immunized donor and a high vitamin diet.

On December 30 an incomplete cauterization of the wound with excision of overhanging edges of skin was performed and again on February 5 1932. Gradual extension of the ulceration occurred however until the patient was admitted to the Stanford Hospital on September 2 1932 17 months after a simple appendectomy and the inception of the infection.

On admission, the patient looked drawn and pale. She was exceedingly apprehensive and fearful of what would be done to her very painful wound. Her temperature was 38.5 pulse 120 respiration 22

hemoglobin 50 per cent red cells 2,500,000 white cells 15,550 polynuclears 82 per cent (47 per cent banded, 35 per cent segmented) lymphocytes 12 per cent, large mononuclears 4 per cent eosinophiles 1 per cent blood pressure 98/68 urine normal weight 92 pounds, average weight 142 pounds.

The condition of the abdominal wall is shown in Figure 3. The actual wound measured 23 by 17 centimeters, but the edges on all sides were under



Fig 4 Case 2 August 16 1934 a, Appearance of wound 3 1/4 years after inception of infection. Note increased involvement of both inguinal regions, resulting finally in a fatal hemorrhage from the right femoral artery b, Progressive ulceration of left lower leg following abscess of heel due to infected arterial embolus incident to ligation of left femoral artery

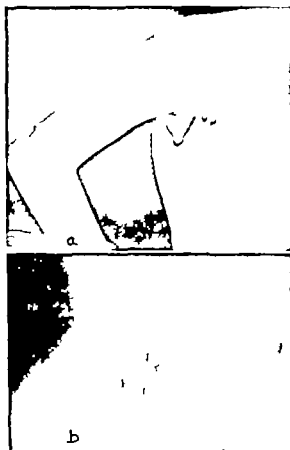


Fig 5 a, September 6 1933 Appearance of axillary wound 7 months following evacuation of abscess secondary to abrasion of finger b Appearance of secondary lesion above knee showing the characteristic appearance of edematous granulation tissue in center and undermining, discoloration, and necrosis of skin edges

mined for 4 to 6 centimeters. The flap of skin and subcutaneous tissue overlying the undermining was in certain areas 2 centimeters thick. The undermining process extended well under the labia.

A blood culture was negative. The cultures of the wound showed the presence of *Staphylococcus aureus*, hemolytic streptococci (beta Brown) and partially hemolytic streptococci (alpha prume Brown). Cultures from beneath the undermined skin on specially prepared media established the absence of anaerobes and fungi.

On September 9 1933 an extensive cautery débridement of the wound was performed by excising all areas of overhanging skin. The labia were almost entirely removed. The surface of the wound was lightly touched with the hot cautery. A disheartening feature was the extension of the infection into the region of the femoral vessels in both groins, thus preventing cauterization of the wound in these areas. A transfusion was given at the end of the operation.

On September 13 the red cells numbered 4,380,000 haemoglobin 53 per cent white cells 18,000 82 per cent polymorphs (70 banded, 12 segmented). On September 20 the white cells numbered 9,100, polymorphs 64 per cent (banded 17 per cent, segmented 47 per cent). Under saline and Dakin's irrigations, the wound improved, and on October 4 the first skin grafting was performed, 82 small deep grafts being applied to the granulation surface. On October 25 132 more grafts were applied, and on November 5 93 more were applied.

A high fever for 3 days on December 19 to 22 led to a blood culture which was positive for *Staphylococcus albus*. A blood culture in a week's time again yielded the same organism. The fever then subsided. A transfusion was performed on January 4, 1933 from an immunized donor. More skin grafts were applied on January 15.

By February 16 the abdomen was epithelialized, but there was considerable undermining of the skin of the left thigh extending down from a sinus tract immediately over the left femoral vessels. This overhanging undermined skin was excised on February 16 followed on March 7 by skin grafting.

On March 27 began a series of episodes which eventually led to death 13½ years later. Within 3 days several massive hemorrhages occurred from an aneurysmal erosion of the left femoral artery. On April 1 a transfusion was given. On April 3 the left external iliac artery was ligated through a clean area above the left superior iliac spine, following which all bleeding ceased. A transfusion was given at the end of the operation. April 13 transfusion. April 26 transfusion. May 2 transfusion. On May 4 the haemoglobin was 76 per cent.

On May 21 though not completely well, the patient returned home at her own request. Small discharging wounds were still present in both groins over the femoral vessels. The patient was instructed to take baths in hypertonic salt and in the sun.

In August all teeth were removed for multiple abscesses.

The patient was re-admitted December 16 1933 for excision of undermined skin surrounding many sinuses in the left inguinal region. The red cells numbered 4,000,000 haemoglobin 85 per cent white cells 20,120 79 per cent polymorphs (73 per cent banded, 6 per cent segmented). Cultures at this time yielded the *Staphylococcus aureus*, a diphtheroid bacillus, the *Bacillus subtilis*, and the hemolytic streptococcus. On December 27 maggots were introduced into both inguinal wounds, but for some reason they refused to remain in the wounds. The pabulum was apparently not to their taste. On January 26 repeated massive hemorrhages from the site of the former erosion of the left inguinal artery necessitated ligation of the artery and division between ligatures. Cultures at this time showed a growth of *Staphylococcus aureus*, hemolytic streptococcus (beta Brown) and *Bacillus pyocyaneus*. Unfortunately the ligation of the artery had to be done in a pus soaked field and immediately after

the operation the patient complained of a painful heel. On March 21, 2 months later a small abscess was opened on the heel which was apparently precipitated by an infected arterial embolus at the time of the above ligation. Cultures from this secondary abscess showed a growth of the hemolytic streptococcus only. The entire left leg was greatly swollen and showed a marked glossy edema over the thigh leg and foot. April 14, 1934 transfusion. On May 18 excision of undermined skin and sloughing Achilles tendon on left was performed. The left foot was practically useless.

On June 4 the red cells numbered 4,600,000 hemoglobin 38 per cent and white cells 12,000. 86 per cent polynuclears (10 per cent banded, 76 per cent segmented) 12 per cent lymphocytes.

On June 6 excision of the undermined skin of the left calf and of the advancing necrosis of the Achilles tendon was repeated. July 5 further excision of undermined skin of the left calf. It had now reached the knee along the intermuscular septa.

On July 8 a massive hemorrhage occurred from the right femoral artery which was temporarily controlled by pressure. On July 31 another exsanguinating hemorrhage necessitated the ligation and division of the right femoral artery and vein. Transfusions were performed on August 2, August 6 and August 10. On August 12 a markedly firm edematous swelling of both thighs and legs developed (Fig. 4). Death occurred on August 17, 33½ years after the beginning of the infection.

In spite of heroic efforts to control an infection which began in an abdominal wound following a simple appendectomy, no headway was ever made in the region where the infection had invaded the inguinal glands and vessels. A bacterial destruction of the left femoral artery resulted in exsanguinating hemorrhages for which the left external iliac artery was ligated. Months later the same vessel again burst forth with terrifying hemorrhages for which the femoral artery itself was ligated and divided at the site of bleeding. Severe massive hemorrhages from an eroded right femoral artery finally resulted in death.

Although the hemolytic streptococcus and the Staphylococcus aureus were always recovered from the original wound only the streptococcus was recovered from the abscess initiated in the left foot by an infected arterial embolus following ligation of the left femoral artery in a pus-soaked field. This secondary lesion spread slowly but insidiously up the leg, with gradual undermining of the skin and involvement of the underlying Achilles tendon and calf muscles.

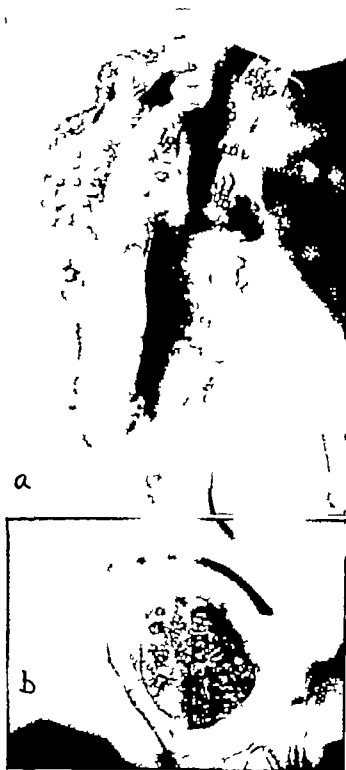


Fig. 6. a, September 30, 1933. Appearance of axillary wound showing its great depth following cautery débridement and introduction of maggots. b, Appearance of lesion on elbow following wide excision of its undermined areas, 23 days previously.

The case provided certain very striking lessons: first the need of early recognition of the irresistible character of the infection if not properly treated, and second, the need of

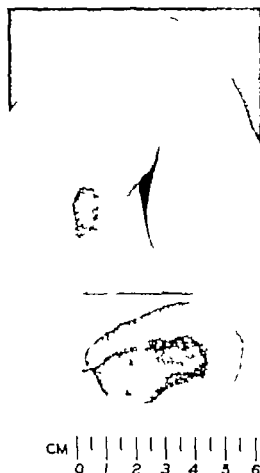


Fig. 9. a, Case 4. Phagedenic ulceration of thigh of 2 weeks' duration following careless picking of small pustule. Patient was a plumber. Healing after 2 months. b, Exposed specimen consisting of base and overhanging edges of ulcerated skin.

excellent functional result. Contractures in the axilla were minimal in spite of a wide spread and deep-seated infection due to its believed to the control of infection without fibrous reaction through the use of maggots. Until healed the wound on repeated occasions yielded the 2 organisms, the hemolytic streptococcus and the *Staphylococcus aureus*.

CASE 4. C. P. J., aged 48 plumber considered himself perfectly well until 2 weeks before admission to Stanford Hospital on July 25, 1934, when he had picked a small pustule on the inner side of his left thigh with an ordinary pin. No dressing was applied, and within a day a sore swollen area developed, followed in another day by ulceration, which has spread rapidly since. The ulcer has been very painful and has discharged considerable pus. Ten days

after the onset the glands in the left groin became swollen and painful.

The patient's occupation as a plumber necessitated contact with sewage and the frequent wearing of rather dirty sewage-soiled trousers.

On admission the examination was negative except for a dirty ulcer on the inner surface of the left thigh about 3 by 6 by 0.5 centimeters in size, the edges of which were undermined and of an angry bluish red appearance. Redness and induration extended beyond the edge on all sides for about 1 to 2 centimeters (Fig. 9). A tender mass of glands was easily palpable in the left groin.

The blood pressure was 160 systolic, 90 diastolic; the red cells numbered 4,800,000, the white cells 8,800, with 78 per cent polymorphonuclears and 20 per cent lymphocytes, hemoglobin 86 per cent, urine, normal Wassermann reaction, negative. A culture from beneath the undermined edge showed hemolytic streptococci of the beta Brown type and a few colonies of *Staphylococcus aureus*. Anaerobic cultures established the absence of anaerobes. The basal metabolic rate on July 27 was minus 23 per cent. The blood sugar was 107 milligrams per 100 cubic centimeters.

On July 28 the entire ulcer including the overhanging edges and the dirty base, was excised with a radio cauter (Fig. 9). The microscopic section revealed only chronic inflammatory tissue.

Following debridement of the wound, 25 small deep grafts were applied to the clean looking ulcerated surface on August 9. Only four took, and these later sloughed off. Also on August 16 33 additional grafts were applied, but again all but seven were floated off in a sea of pus.

In spite of the administration of 2 grains of thyrotoxin daily the basal metabolic rate on August 23 was minus 25 per cent.

Under active debridement, the wound gradually cleared and the patient was discharged September 2 with the edges slowly growing in. By September 25 complete healing had taken place.

The important points of interest in connection with this case are (1) the occupation of the patient which requires contact with sewage (2) the presence of both the streptococcus and the staphylococcus in the wound though neither was anaerobic in character (3) the low basal metabolic rate (4) the slow but steady healing that occurred following cauter debridement of the ulcer which had given promise of being an insidiously progressive lesion.

EXPERIMENTAL DATA

Two dogs were injected with organisms obtained from Case 3. The hemolytic streptococcus was injected subcutaneously in the left flank, the *Staphylococcus aureus* in the

right flank, and an emulsive mixture of the two at the xiphisternum. In each instance a definitely more pronounced reaction occurred at the xiphisternum than in the flanks, with central sloughing at the site of injection over a very limited area. Prompt healing followed the spontaneous evacuation at the site of sloughing of a small amount of thin pus.

In a third dog a remarkable gangrene of the skin and muscles of the chest wall occurred, causing the death of the animal in 3 days, but cultures of the pus revealed, in addition to the streptococcus and staphylococcus, the presence of Welch's bacillus.

In 2 other animals the *Staphylococcus aureus* obtained from Case 4 was injected first, causing a mild reaction. At the height of reaction, the hæmolytic streptococcus obtained from the same case was injected at the same site. The reverse order was attempted in another animal but in each instance no gangrene nor spreading infection occurred.

A sixth animal was similarly injected with the organisms recovered from Case 3 namely an aerobic streptococcus and an anaerobic staphylococcus, without producing any lesions other than small abscesses which healed promptly.

DISCUSSION

Four cases are presented, exhibiting the characteristic features of the progressive and relentless bacterial ulceration of the skin and subcutaneous tissues described in the literature most commonly as a complication following operation for a ruptured appendix. In reviewing the recorded cases one cannot escape the inference that some intestinal organism or organisms are in some way responsible for these remarkable infections. In the 4 cases reported here, 1 followed an appendectomy, 2 followed the draining of axillary abscesses secondary to lesions of the hand—1 incurred while handling animal fertilizer, the other incurred while grating carrots, a product of the field, and the fourth occurred in a plumber whose clothes were habitually soiled by sewage.

Meleney's cases have invariably yielded in culture a non hæmolytic, micro-aerophilic streptococcus, which together with the *Staphylococcus aureus* he considers specific for

this type of infection, and his hypothesis that it is due to a bacterial synergism, a symbiotic phenomenon involving the two organisms, has found ready acceptance. Little corroborative evidence is to be found in the recorded cases due to lack of uniformity in the bacteriological studies made, and due to the great variety of organisms recovered from the lesions. In the cases here presented two organisms were in variably found, but the streptococcus recovered was hæmolytic and aerobic.

Moreover, in the recorded cases Christopher, Cullen Shipley, Poate Ballin and Morse, Carol and Horsley report the recovery of only the hæmolytic streptococcus from the wounds of their patients, and in two instances—Luckett, and Probst and Seelig—only the staphylococcus was recovered. Of more than usual interest in a group of patients reported by Stookey, Ferris et al., who observed as a complication of erysipelas the development of necrotizing ulcers, from which a pure culture of *staphylococcus aureus* was obtained. The necrotizing factor they attributed to a bacteria free filtrate presumably an exotoxin, recovered from cultures of this staphylococcus. When this filtrate was injected intracutaneously into the skin of a rabbit, necrosis invariably occurred, although filtrates from the *Streptococcus erysipelas* and from a *Staphylococcus aureus* recovered from a furuncle, yielded no such necrotizing element. The authors postulate a specific staphylococcus possessing dermonecrotic properties.

Our animal experiments with attempts to reproduce the lesion by inoculation of two organisms singly and in combination, corroborate Meleney's observation that two organisms together produce more pronounced lesions than single organisms, but in no instance were we, or Meleney, able to reproduce the progressive lesion seen in the human cases.

Experiences such as these almost force one into that mysterious wilderness of medical knowledge, the realm of individual resistance to infection and the highly enigmatical state of virulence of the infecting organisms which may exhibit extraordinary and highly individualistic qualities under different conditions.

TABLE I.—RECORDED CASES OF PROGRESSIVE ULCERATION

Author	Patient Sex Age	Source	Duration	Organisms recovered	Treatment
Lackitt 909	M 33 (Germans)	Parasite of abscess	3 weeks	<i>Staphylococcus aureus</i>	Ointery
Christophers 924	M 84	Empyema (lung abscess)	13 days	Anaerobic streptococcus Bacillus coli Gram negative strep	Ointery Trichostatin
Cullen 7944	M 50	Appendical abscess	5 weeks	<i>Streptococcus faecalis</i>	Ointery
Mayeda 1236	M 36	Appendical abscess	4 months	<i>Streptococcus</i> <i>Staphylococcus</i> Bacillus coli	Widespread antiseptics and light therapy Ointery
Brewer and Johnson 936	M 4 M 84	Appendical abscess Appendical abscess	3 weeks weeks	Variety of organisms Hemolytic staphylococcus Anaerobic non-hemolytic streptococcus Diphtheroid bacillus	Ointery Ointery (twice)
Alexander 1936	M 33	Appendical abscess	18 months	Hemolytic streptococcus Staphylococcus	Antiseptics Light therapy Burnt steel set
Gulley 934	M 30	Appendectomy	months	<i>Staphylococcus aureus</i> + diphtheria <i>Streptococcus</i>	Salvarsan XI Chemicals Ointery
Slipley 933	?	Appendical abscess	4 months	Non-harm strep.	Antiseptics Ointery
Prudhomme and Seely 938	F 35	Abscess of breast	9 months	<i>Staphylococcus aureus</i> Pure culture	Multiple incisions Amputations breast 6 transfusions from bloodless disease
Cole and Hordeman 939	M 34	Appendical abscess	6 months	Hemolytic streptococcus ? Anaerobes	Antiseptics Radiant therapy Ointery
Potts 930	M 16	Thoracotomy for empyema complicating pneumonia	6 months	<i>Streptococcus</i>	Death after 6 months
Hallstrom 7930	M 54	Appendical abscess	3 months	Bacillus coli gram negative Bacillus	Intensive chemicals Ointery
Lyons 93	M	Appendical abscess	months	<i>Streptococcus</i> <i>Staphylococcus aureus</i>	Ointery
Hall and Marks 93	M 34 M 3	Empyema complicating liver pneumonia Appendical abscess	months weeks	<i>Streptococcus</i> Anaerobic strep Diphtheroid bacillus	Repeated incision Ointery
McIntyre 93	M 5	Intra-abdominal abscess appendical	21 days	Microaerophilic non-harm strep Hemolytic <i>Staph aureus</i>	Ointery
Carol 93	M 6	Appendical abscess	4 months	<i>Streptococcus</i> Bacillus coli	Mixy antiseptics Ointery Death from exhaustion
Baker and Terry 1937	M 3	Appendical abscess	7 months	Non-harm strep Hemolytic staphylococcus	Mixy antiseptics + blood transfusions Ointery Death from septicemia
Horsley 93	M 45	Appendical abscess	1 1/2 yrs	<i>Streptococcus</i> Gram + diphtheria Gram - bacilli	Ointery
P. Thomas 937	M 6	Empyema complicating perforated appendix	13 months	Hemolytic strep Microaerophilic strep	Widespread antiseptics Ointery (twice)
McIntyre 933	M 63 ? M 57	Carcinoma sigmoid Appendical abscess Perforated duodenal ulcer Relapsing abscess	27 days 20 days 14 days	Anaerobic non-hemolytic strep <i>Staphylococcus</i> Bacillus proteus Non-harm microaerophilic <i>Streptococcus</i> <i>Staphylococcus</i> Bacillus proteus Microaerophilic non-hemolytic strep Hemolytic <i>Staphylococcus aureus</i> <i>Staphylococcus albus</i>	Excision Excision Excision

In our fourth case, efforts to study the factor of individual resistance resulted in an unusual finding. The patient on two occasions showed a basal metabolic rate of minus 23 and minus 25 per cent. Case 3, when on the road to recovery, however, showed a normal metabolic rate of plus 7 per cent. No deductions may be made on the evidence available.

In treating such infections every effort should be made to increase the resistance of the host to infection. This may be accomplished by transfusions, by sun baths and by a high vitamin diet augmented by cod liver oil and vitamin B. The case of Probst and Seelig responded promptly and decisively to blood transfusion from immunized donors.

Locally, the resistance of the host to the infecting organisms was affected in our axillary abscesses by the introduction of maggots which, according to Baer's unique and highly original observations remove, by ingestion, necrotic and near necrotic tissue, and change the hydrogen ion concentration of wound secretions toward the alkaline side—two factors destined to reduce the propagation of the infecting organisms by rendering the local conditions unfavorable.

In adopting maggot therapy, two precautions must be observed. (1) Adequate medication, such as morphia, pantopon, or sodium amytal, should be employed every 2 hours to control pain. (2) Maggots must be used in sufficient number so that every part of the wound is being attacked simultaneously.

The success of the débridement lies in carrying the incision boldly and courageously through absolutely healthy skin and subcutaneous tissues, and abolishing all pockets where pus may accumulate and stagnate. There must be no hedging in this procedure; all overhanging tissue must be removed. It is possible that pools or pockets of pus exhaust the defensive mechanisms of the body and once these pockets are removed, the defensive forces may gain the ascendancy. In this connection it is interesting to note the reaction of the polymorphonuclears to the extensive infection in Case 2. On the patient's first admission, in the presence of an advanced infection the white cells numbered 15,550; 82 per cent polynuclears, 47 per cent banded and 35

per cent segmented. Eleven days later, 4 days after an extensive débridement, the white cells numbered 12,000; 82 per cent polynuclears, 70 per cent banded, 12 per cent segmented. Thirteen days later, when the suppuration was under much better control, the white cells numbered 9,100; 64 per cent polynuclears, 17 per cent banded, 47 per cent segmented.

On the second admission, again in the presence of marked suppuration, the white cells numbered 20,120; 79 per cent polynuclears, 73 per cent banded, 6 per cent segmented. On June 4, still in the presence of widespread suppuration, the white cells numbered 12,000; 86 per cent polynuclears, 10 per cent banded, and 76 per cent segmented. Death occurred on August 17. On the first admission, the observations might have been considered significant; the later studies were contradictory.

It seems very unlikely, from the fatal outcome in Case 2, that the deep-seated axillary abscesses in Cases 1 and 3 could have been successfully treated without recourse to maggot therapy. Complete cautery débridement and the abolition of all pockets was obviously impossible. Only maggots could cope with the dirty oedematous granulation tissue, containing numerous organisms, which extended in each instance to the very apex of the axilla. One unexpected advantage resulting from the maggot therapy was the kindly healing that occurred in both axillary abscesses without permanent cicatricial contractures. Full range of motion is now present in both of the patients with deep axillary abscesses recorded here; attributable it is believed to maggot therapy. In treating axillary abscesses it is important to support the arm in the abducted position by means of the Balkan frame.

SUMMARY

Four cases of progressive bacterial ulceration of skin and subcutaneous tissue are presented, one cured by maggot therapy alone, one by cautery débridement and maggot therapy, and one by cautery débridement alone. A fourth case succumbed following repeated massive hemorrhages from eroded femoral arteries, in spite of repeated débridements, which were ineffectual due to the involvement of the femoral sheath.

BIBLIOGRAPHY

1. ALEXANDER, E. G. Postoperative-operative, spreading superficial gangrene. *Ann Surg* 1926, 84: 451-463.
2. BAKER, WILLIAM S. The treatment of chronic osteomyelitis with the maggot (larva of the blow fly). *J Bone & Joint Surg* 1931, 3: 438.
3. BAKER, W. H. and TERRY, C. C. Case of postoperative progressive gangrene of the skin. *J Am M Ass* 1932, 95: 138-139.
4. BAILLIE, M. and MORRIS, P. Progressive postoperative gangrene of the skin. *Am J Surg* 1931, 11: 81-87.
5. BECKER, G. E. and MILENCY, F. L. Progressive gangrenous infection of the skin and subcutaneous tissues following operation for acute perforative appendicitis, a study in symbiosis. *Ann Surg* 1926, 84: 435-450. *Tr. Am Surg Ass* 1926, 44: 380-410.
6. CHRISTOPHER, F. Severe spreading carbuncular infection of the chest wall following rib resection under local anesthesia. *Surg Clin N America*, 1924, 4: 795-800.
7. COLE, W. H. and HEIDEMAN, M. L. Amebic ulcer of abdominal wall following appendectomy with drainage, report of a case. *J Am M Ass* 1929, 92: 537-540.
8. COLLIER, T. S. A progressively enlarging ulcer of the abdominal wall involving the skin and fat, following drainage of abdominal abscess apparently of appendiceal origin. *Surg Gynec & Obst* 1924, 38: 570-583.
9. GILLESPIE, M. G. Phagedenic ulceration of skin. *Ann Surg* 1908, 48: 245-251.
10. HELLSTROM, J. Zur Kenntnis der post operativen Bauchwand nekrosen nach Laparotomien. *Acta Chirurg. Scand.*, 1930, 66: 184-196.
11. HOLMIST, J. S. Certain symbiotic bacterial infections producing gangrene with special reference to the principles of treatment. *J Am M Ass* 1932, 95: 1425-1429.
12. KAPPA, M. Eine eigenartige, von Operationswunden ausgehende fortbreitende Hautnekrose. *Beitr. z. klin. Chir* 1932, 155: 170-200.
13. LOCKETT, W. H. Large phagedenic ulcer of abdomen. *Ann Surg* 1909, 50: 605-608.
14. LYNN, F. S. Postoperative gangrenous ulcer of the abdominal wall. *J Am M Ass* 1931, 97: 1597-1602.
15. MAYEDA, Eine seltsame Hautgeschwulstbildung nach der appendektomie. *Deutsche Ztschr f Chir* 1927, 190: 350-353.
16. MILENCY, F. L. Bacterial synergism in disease processes, with confirmation of the synergistic bacterial etiology of a certain type of progressive gangrene of the abdominal wall. *Am Surg* 1931, 91: 961-981.
17. PATTERSON, H. A. Progressive postoperative cutaneous gangrene. *Ann Surg* 1932, 95: 1091-1097.
18. PROBERT, J. G. and SEELIG, G. The treatment of postoperative progressive gangrenous infection of the skin and subcutaneous tissues with blood from immunized donors. *Surg Gynec. & Obst* 1928, 47: 247-251.
19. SHIPLEY, A. M. Progressive gangrenous ulceration of abdominal wall. *Ann Surg* 1928, 87: 245-249.
20. STOOKLEY, P. F. FERRIS, C. R., et al. Necrotizing ulcers complicating erysipelas. *J Am M Ass* 1934, 103: 903.

Discussion

DR. EDWARD D. CHURCHILL, Boston. When a scientist asks for a frog to use for a crucial experiment he expects to be given a frog and not an animal that may be a frog. To obtain consistent bacteriological findings to support a theory as to the causative agent of a disease, the clinician must first of all be certain that his cases are all examples of a single disease entity. There is real difficulty ahead in attempting to assign a specific etiological agent to a variable and protean disease as chronic progressive superficial ulceration. Although our bacteriological technique may be exact, we start with an incorrect clinical diagnosis. These ulcerations that Dr. Holman has described have many manifestations that are the same as those seen in a group we have studied at the Massachusetts General Hospital. The cases correspond to Dr. Melency's group and to many other cases reported in the literature but the clinical identity may well not check with the bacteriological identity. We have found by animal inoculation that the microaerophilic streptococcus and staphylococcus recovered from many of these ulcers do appear to represent the disease more nearly when injected as a mixed culture than when injected singly. However the confusion in nosography rests as much on clinical findings as on bacteriological analysis.

Fortunately the proper treatment may be carried out irrespective of these uncertainties as to etiology.

The prompt recognition by surgeons of the fact that superficial ulcerations anywhere upon the body may be relentless in their progression and fail to respond to any of the usual surgical methods of control is important. If they are correctly treated at an early stage, months or years of invalidism or a final fatal termination may be prevented.

I have found personally that an excision of the margins of these ulcers with the electrocautery knife followed by skin grafting is the most effective method of control. It is only effective, however if the ulceration is still so limited that it may be excised. I have lost a case that extended into the perineum and the femoral sheath. I have lost a second case that started as a simple breast abscess but at the time the condition was recognized involved over one-half of the entire chest and abdominal wall and was complicated by sinuses extending under ribs that had previously been resected. We have cured at least 7 patients in whom the lesion, although extensive in some instances, could be radically excised.

I believe that the ulcer Dr. Holman has described is essentially a disease of the subcutaneous tissue and that its manifestations vary in different portions of the body depending upon the thickness of this layer. The skin melts away following the destruction of its blood supply through the undermining infection. In abdominal cases the umbilicus is usually left at

the apex of a peninsula because of the lack of subcutaneous fat beneath it. On the dorsum of the hand the skin may actually gain a new blood supply and remain viable in the center as the active process extends peripherally.

A very important aspect of these cases that Dr Holman has stressed is the mental attitude of the patient. Many of them have been treated by a series of doctors, each one of whom promises relief at the outset only to find himself faced with defeat after the unsuccessful use of one or more new methods of treatment. The exquisite pain of repeated surgical dressings breaks the morale of the most phlegmatic individual. Most of these patients accept further treatment with reluctance or with a complete lack of confidence. I recall vividly one patient who had

been treated for a year with sunlight therapy under a diagnosis of tuberculosis suggested by the coincidence that the ulceration followed the removal of a tuberculous pyosalpinx. During this year the patient watched the steady progression of the ulcer until it extended from above the umbilicus to the pubes and from one iliac crest to the other. To gain the confidence of this patient it was necessary to delay operative procedures for 3 weeks and build up her morale by occupational therapy and psychiatric consultation. Even when completely healed this individual was forced to spend over a year in a mental institution to recover from the effects of the disease. Surgeons must recognize the true nature of these ulcerations at an early date if such serious complications are to be avoided.

SOME REMARKS ON THE GIANT CELL TUMOR OF BONE¹

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THE tumor known under the various titles of giant cell tumor myeloid sarcoma, or osteoclastoma, is somewhat of a clinical enigma to the practical surgeon of today. There are three main reasons for this state of incertitude: (1) the tumor can no longer be regarded as a histological entity—a fact which has an important bearing on the problems of diagnosis and treatment; (2) the tumor is rare and its clinical behavior variable; and (3) in the treatment of the tumor there appears to be a tendency to substitute some form of irradiation for early surgical intervention.

THE IDENTITY OF THE GIANT CELL TUMOR

To the surgical generation which immediately succeeded Paget (1853) and Nélaton (1860) the myeloid sarcoma, as it was then usually called, appeared securely established as a clinical and histological entity. It was sufficient merely to emphasize the distinctions between it and the true sarcoma of bone. Until the advent of von Recklinghausen's classical description of generalized osteitis fibrosa (1891) this conception remained unchallenged. But with the ultimate widespread recognition in more recent years, that typical osteoclastomata can almost invariably be found in the varied histological pattern which characterizes the osteitis fibrosa group of lesions, the separate identity of the giant cell tumor is now by no means so obvious. For here is the seeming paradox of a histological picture shared by two lesions generically opposed: on the one hand a true tumor of bone—an osteoclastoma—which behaves in every particular as a neoplasm, and, on the other, a dystrophy of bone admittedly non-neoplastic, which exhibits a striking tendency toward spontaneous healing. For the moment we are concerned only with one clinical type of osteitis fibrosa—the solitary bone cyst.

The outstanding differences between the clinical picture of the bone cyst in children and the giant cell tumor in the adult are fa-

miliar to all surgeons. Some of the main points relating to age and sex incidence, skeletal distribution, site of origin, and clinical course are conveniently summarized in Table I.

TABLE I

	Solitary bone cyst		Giant cell tumor	
Age	5-15 (males 90)		20-35 (females 90)	
Sex	M > F		F > M	
Site of Election	Proximal Femur	Upper end of Tracheostome region	Proximal Femur	Lower end of Upper end of Lower end
Site of origin	Metaphyseal		Epiphyseal	
Clinical course	Trauma → Fracture Spontaneous healing++		(Trauma) → Spontaneous healing Laminate and destructive	

Geschickter and Copeland (2) for whose work on this subject I have the greatest admiration, believe the average bone cyst to be a giant cell tumor which has either already healed or is in process of healing. These authors also recognize as histological entities (a) a giant cell variant of osteitis fibrosa, and (b) a spindle cell variant of the giant cell tumor. These hybrid lesions, which have been described by Geschickter and Copeland more especially in the cysts of the miniature long bones, form a connecting link between the cyst at one end of the scale and the giant cell tumor at the other.

I would urge that the significance of the histological kinship between the cyst and the giant cell tumor be not unduly stressed. There is a danger that this fascinating argument if carried too far may tend to disturb the clinician's sense of perspective and lead not only to hesitancy in diagnosis, but—most important of all—to delay and imprecision in the treatment of the giant cell tumor. It is far wiser in my judgment, that we should continue to emphasize the complete independence, as clinical and pathological entities, of the two lesions under consideration. By so doing we are able to formulate principles which will determine the rational treatment of the giant cell tumor. For whereas a cyst may often be treated at leisure by conservative methods, I

am of the opinion that, with certain exceptions, a giant cell tumor should without delay be eradicated by appropriate surgical measures.

Despite the underlying histological unity between the two lesions, when compared with the typical bone cyst the ordinary giant cell tumor is quite obviously a definitive clinical entity. But solitary cystic lesions of bone from time to time present themselves, which do not conform exactly to type and which, at first sight, might be legitimately mistaken for giant cell tumors. These are cysts exhibiting rapid growth with perforation of the bone shell, after the manner of a true tumor and generally occurring in young adults. Such cysts may contain liquid blood in addition to clumps of tumor like tissue of varying consistency and hue. In the absence of a definite fibrous lining to the cyst wall this tissue is not easily distinguishable, on naked eye appearances, from true giant cell tumor material in older individuals. The two following cases from my own collection illustrate some of the uncertainties which may arise in this connection.

CASE 1. Female, aged 15 years. Cyst of pubis, left.

The symptoms, pain in left groin and intermittent lump, had been present 3 months. There was no trauma.

Examination revealed a swelling along the brim of the pelvis on the left side.

X ray examination showed expansion of the body of the pubis and pubic ramus on the left side with partial disappearance of the ramus (Fig. 1).

Operation consisting of curettage and cauterization of the cyst was done October 29, 1923. The bony shell had largely disappeared but an intact fibrous capsule was discovered which formed the wall of a large cyst containing liquid blood and masses of tumor like tissue. *Severe hemorrhage was experienced*, which necessitated temporary packing. The contents of the cavity were evacuated and the interior cauterized with pure carbolic acid.

Histological examination revealed an active cellular picture, consisting of round and spindle cells with well marked giant cell areas, giant cells scanty but large with many nuclei, areas of osteoid bone and hemorrhages.

Result. Complete obliteration of the cyst with reformation of pubic ramus (Fig. 2).

A rapidly growing cyst of the osteitis fibrosa group in an unusual site and containing liquid blood and tumor like tissue was suggestive of

the naked eye of a giant cell tumor. The lesion showed well marked invasive qualities but was cured by curettage and cauterization.

CASE 2. Female aged 23 years. Cyst of femur lower end, left.

The symptoms were of 9 months duration and consisted of pain in the left knee followed by the appearance of a lump on the inner side of the thigh which rapidly increased in size, no trauma, severity of pain a striking symptom.

Examination revealed a localized bony expansion of the left femur just above the inner condyle, tender on deep pressure.

X ray examination disclosed an eccentric multicystic expansion involving the lower part of the shaft of the femur immediately above the inner condyle. The site of origin was the *metaphysis*, the bony shell was attenuated on the superficial aspect and absent in places (Fig. 3).

Operation on December 11, 1931, amputation was done through the middle third of the thigh.

Description of specimen. The cyst was almost completely empty except for the presence of a small amount of clear fluid, the interior was lined with patches of tissue, lightly adherent to the bony shell, this tissue in places was tough and fibrous but over the greater part of the cyst wall was friable and presented the maroon color of a giant cell tumor.

Histological examination of the cyst lining revealed a fibrous tissue and spindle cell background containing typical giant cell tumor areas, the giant cells were in moderate numbers, large, and contained many nuclei (Fig. 4).

Result. Three years later, the patient is well wearing an artificial limb and following her occupation.

This is also to be regarded as an atypical bone cyst of the osteitis fibrosa group. True to type, the lesion originated in the *metaphysis* but was eccentrically placed, after the manner of a giant cell tumor of the epiphysis. The age of the patient, the rapidity of growth and the radiographic appearances, are also reminiscent of giant cell tumor. Owing to the size, position, and rapid growth of the cyst, it was considered unsuitable for treatment by curettage. Local resection was also rejected as involving a mutilating operation with a long postoperative period of disability. The patient herself was anxious to return to her occupation at the earliest moment and eagerly concurred in the suggestion of amputation.

I believe that a cyst which runs an atypical course—as in the examples quoted above—like the proverbial leopard, does not really “change its spots.” Such cysts are neither

hybrids nor atypical giant cell tumors. It seems logical to look upon them as true bred cysts of the osteitis fibrosa group in which an unusually active tissue proliferation has resulted in bone destruction. Indeed the problem of the rapidly growing cyst in the adult has even wider implications. For it is well known that benign cysts eccentrically placed at the end of a long bone, and packed with actively proliferating spindle cell tissue, have not infrequently been diagnosed as sarcomata and treated by amputation of the limb! We may therefore conclude that the occasional tendency of a bone cyst to run amuck and assume tumor like activities, does nothing to invalidate the position of the giant cell tumor as a neoplasm *sui generis* and as an independent clinical entity.

CLINICAL ATTRIBUTES OF THE TUMOR

One of the most striking facts about the giant cell tumor of bone is its undoubted rarity (I am excluding for the moment the common periosteal *spulis* of the jaw which lies outside the clinical problems under consideration) It has been estimated that the average yearly quota of giant-cell tumors of the long bones in the larger general hospitals of Great Britain, is not more than one tumor per year per hospital (Stewart, 6) It is evident that the majority of hospital surgeons do not enjoy a continuity of experience which enables them on every occasion to deal authoritatively with a tumor which makes so infrequent an appearance. In this generation however the surgical profession has the inestimable advantage of being able to turn to the wealth of knowledge made available by the intensive study of bone tumors on an unprecedented scale in the United States of America. Every surgeon who is continuously interested in this problem, must feel impelled to voice his lasting indebtedness to four great pioneers in this effort J C Bloodgood E A. Codman, W B Coley and J S Ewing.

A contemplation of the giant cell tumor in its various guises would seem to warrant a recognition of three clinical types—(1) the indolent, slowly growing tumor, (2) the active, rapidly growing tumor and (3) the rare, malignant tumor. At the same time one cannot

escape the impression that no two tumors behave alike.

1 *The indolent tumor* The indolent tumor is characterized by a very slow rate of bony expansion over a considerable period of time. Its relatively feeble invasive and destructive qualities are made manifest (a) in the roentgenographic picture of a thick bony wall and coarse trabeculation and (b) in the histological picture by the presence of considerable areas of fibrous tissue. This histological type of giant cell tumor was well known to the older pathologists, who regarded the fibrous tissue reaction as an attempt on the part of the tumor to undergo spontaneous healing (Ribbert).

Indolent tumors have formed a very small proportion of my own series of giant cell tumors and as it happens, they have all been growths of the lower end of the femur in individuals under 30. I do not attach any importance to the question of site, but I believe the age factor is significant and that slowly growing tumors endowed with very feeble powers of invasion are exceptional after the age of 35.

2 *The active tumor* The active, more rapidly growing tumor showing well marked invasive and destructive qualities seems to represent the giant cell tumor in its true colors. The clinical picture is a familiar one. With symptoms of comparatively recent origin, the tumor is already appreciable on clinical examination and is known to be steadily increasing in size. The bony shell, as depicted in the roentgenograms, is attenuated and already perforated at one or more points. The microscopic picture is characterized by a profusion of giant cells, embedded in a background of actively growing cells, both of the round and spindle type.

The active type of giant cell tumor is met with in the young adult as well as in individuals approaching middle age or even later and its behavior does not appear to be determined by its selection of site. The more one has to do with the giant cell tumor the more one is impressed by its invasive and destructive qualities, especially in individuals over 30. It is because of such activities that I am accustomed, when teaching students, to refer to

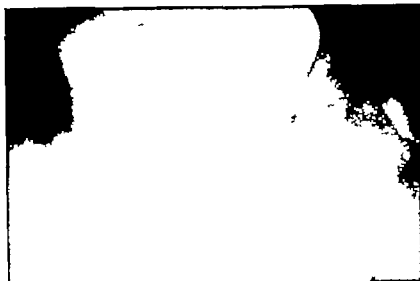


Fig. 1 Case 1. Cyst of pubis (osteitis fibrosa) in a girl aged 15. A cystic expansion of body and ramus of pubis on left side with considerable destruction of bony shell.



Fig. 2 Case 1. The roentgenogram shows reformation of the pubic ramus 4 years after the operation of curettage and cauterization.

the tumor as a *malicious* although not a malignant, neoplasm. I have probably been influenced by the fact that more than half of the cases in my own series have been patients in the fourth or even fifth decade of life. Indeed, the surprising incidence of this tumor in the middle aged occasionally leads to difficulties in the differential diagnosis of solitary secondary malignant tumors of the long bones, where the primary growth is latent.

The inherent aggressiveness of the typical giant cell tumor is convincingly demonstrated in its tendency to recur locally after operations which, at the time, may have appeared sufficiently radical. The following case from my own collection is instructive in this respect.

CASE 3. Female aged 23. Giant cell tumor of head of femur right.

The patient had had pain and a limp for 6 months. Examination disclosed the clinical picture of a subacute arthritis of the right hip joint.

A ray examination revealed a faintly trabeculated cyst, occupying the lower half of the femoral head and extending into the lower border of the neck. Bony shell almost disappeared (Fig. 5).

The first operation was done December 18, 1931, at which time the hip joint was explored and the head and neck of the femur resected.

When the hip joint was opened and the femoral head inspected, a localized bulge of encapsulated tumor material was noted at the junction of the lower border of the head and neck. The femoral head was flattened and triangular in shape and showed a perforation of the articular cartilage in the region of the attachment of the ligamentum teres. Through this

perforation a tiny clump of tumor tissue was on the point of escaping. An effective curettage and cauterization operation was regarded as impracticable. Accordingly the femoral head and neck were excised *en masse*, the neck being divided well beyond the presumed margins of the tumor. The stump of the upper end of the femur was cauterized with carbolic acid in the usual way. During the operation a rapid smear (Dudgeon technique) of the tissue protruding through the hole in the articular surface of the femoral head showed the characteristic cells of a benign giant cell tumor.

Description of specimen. About one half of the interior of the femoral head was occupied by a multilocular cystic area containing reddish brown tissue with 'red-currant' areas. There was a perforation of the articular surface in the region of the ligamentum teres attachment (Fig. 6).

Histological examination of contents disclosed a typical benign giant cell tumor with giant cells in great profusion. (Fig. 6).

As it was believed that a clean sweep had been made of the tumor it seemed reasonable to attempt to stabilize the hip joint at an early date. Some 2 months after the excision of the tumor a second operation was performed (February 15, 1932) and included a reconstruction of the head of the femur by a homogenous graft. The astragalus removed from a patient of a similar blood group with a long standing ununited fracture of the leg bones, was attached to the upper end of the femoral shaft (Fig. 7). There was no naked eye evidence of recurrence of the tumor. Four months later the patient was fitted with a walking caliper. The hip joint was surprisingly stable and allowed a short range of movement. Six months from the time of the operation a roentgenographic examination showed a cystic change in the upper part of the shaft, suggesting recurrence of the tumor (Fig. 8). There was no clinical evidence to support this conclusion. The patient was unwilling



Fig. 3. Case 2. Cyst of femur (osteitis fibrosa) in a female aged 23. A large cyst arising eccentrically in the metaphysis showing marked thinning of the bony shell on the superficial aspect.

to give consent for further operation and, therefore, a course of deep X-ray therapy was advised. Valuable time was lost before arrangements could be made for this treatment. In the meantime the cystic area had steadily increased in size (Fig. 9). After the course of deep therapy the hip remained very painful, there was an increasing swelling of the soft parts, and the joint became completely fixed. A further roentgenogram showed no shrinkage in the tumor area. The question of amputation was discussed but the patient consented only to a further local attempt to excise the tumor (Fig. 10).

A third operation consisting of re-exploration and excision of upper end of femur was done.

July 24, 1933 the dense fibrous and adherence of the soft tissues to the bony shell and capsule of the tumor made the operation extremely difficult. As it was not felt certain that every particle of the bone shell and capsule had been eradicated, the operation wound was re-opened 15 days later and radium tubes, enclosed in a sorbo rubber pack, were inserted. Progress following the operation was most satisfactory and sound healing of the wound rapidly occurred. Two months later the patient began to bear weight on the limb in a caliper splint.

Result up to date. One year after the last operation, there is no clinical or radiographical evidence of recurrence in the upper end of the femur. There is

gross shortening of the limb but the patient is able to walk quite comfortably in the caliper splint (Fig. 15).

1. A giant cell tumor actively invasive and destructive, occurring in an unusual situation and treated by a radical excision of the tumor bearing area (head and neck of the femur). A re-exploration of the hip joint 2 months later for the purpose of insertion of a homogenous graft, afforded an opportunity of demonstrating the absence of naked eye evidence of local recurrence.

2. Unmistakable roentgenological signs of recurrence in the upper end of the femur were discovered 6 months from the time of the reconstructive operation and ultimately the homogenous graft (astragalus) was completely invaded by tumor.

3. The recurrent tumor which rapidly attained to a considerable size continued to grow in spite of irradiation (deep X-ray therapy).

4. The recurrent tumor was treated by excision and radium implantation.

5. The patient is still under observation and has remained free from signs of recurrence for a year from the date of the last operation.

I have recorded elsewhere a similar example of the recurrence of a giant cell tumor in a bone graft used to replace the metacarpal bone of a thumb after a previous excision of the original tumor (4).

3. *The malignant giant cell tumor.* The question of the potential or actual malignancy of the giant cell tumor has in the past excited considerable controversy. It is now generally admitted that on very rare occasions, the tumor may assume all the local and metastatic attributes of a true malignant neoplasm. Whether this phase of activity represents a superimposition of malignancy on a benign tumor (Geschickter and Copeland, 1) or—more probably—a true dedifferentiation of the specific cells of an osteoclastoma (Stewart, 7) still remains to be settled by the pathologist. It is the sequence of events in the clinical story of the true malignant giant cell tumor which concerns us at the moment—a tumor with a long career appearing in the first instance as a typical benign lesion between the ages of 30



Fig 4 Case 2 Histology showing parts of a giant cell tumor area

and 40 and recurring locally on several occasions after curettage or even after local resection, and progressing to ultimate metastasis in spite of belated amputation. The lessons to the practical surgeon are obvious (1) the necessity for a truly radical removal of the tumor at the first attack, and (2) the desirability of being able to recognize the onset of malignancy in a neglected or recurrent tumor before the stage of dissemination.

In a recent contribution E S J King of Melbourne, has described the histological and roentgenographic criteria on which a diagnosis of impending or actual malignancy may be made in atypical giant cell tumors. These in his opinion, are (1) a predominating spindle cell stroma with mitoses and tumor giant cells in addition to the typical benign giant cell areas in other parts of the tumor, and (2) loss of outline of the bony shell irregular trabeculation, and the shadow of tumor material in the soft parts. King also challenges the well known dictum of Bloodgood that perforation of the bony shell is not necessarily a sign of malignancy. My own experience would tend to confirm the soundness of Bloodgood's teaching for I have cured by curettage and cauterization tumors in which the bony shell had almost disappeared. The fibrous capsule was however still intact. But even the ultimate perforation of the fibrous capsule and the invasion of the surrounding soft parts, are in

themselves no proof of malignant behavior although they obviously call for drastic excision of the tumor bearing area, or amputation.

Neglected tumors which fungate through the skin are fortunately an uncommon experience at the present day. I have had one example of this unusual clinical phenomenon in a tumor of the lower end of the fibula in a woman of 42 years with a comparatively short history and treated by a previous curettage. The histological picture was a typical benign osteoclastoma but no complete histological survey of the greater part of the tumor was made (Fig 12). The patient was known to be alive and well 1 year after amputation but all efforts to trace her during the past 10 years have been unsuccessful.

So far it has not fallen to my lot to meet with an example of true malignancy in a giant cell tumor.

TREATMENT OF THE GIANT CELL TUMOR

It will be generally agreed that, in the treatment of the giant cell tumor our aims should be the complete eradication of the tumor with the minimum amount of mutilation. It is, therefore, pertinent to ask how far surgical treatment, as a primary resort, fulfills these requirements. The rôle of three types of operation must be considered (1) curettage, (2) local excision, and (3) amputation.



Fig 5



Fig 7



Fig 8

- Fig 5 Case 3 Giant cell tumor head of femur (R) in a female aged 23. Lower half of the femoral head has been replaced by faintly trabeculated cyst extending into lower part of neck
 Fig 7 Case 3 Femoral head and neck replaced by transplanted astragalus
 Fig 8 Case 3 Six months after astragalus transplantation. Decrease in size of the transplant and cystic areas in the upper part of the femur suggesting recurrence of the tumor

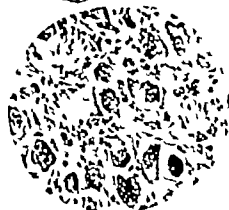


Fig 6 Case 3 Resected specimen. Histological features—great profusion of large giant cells

SURGICAL MEASURES

1. *Curettage* The conservative operation of curettage and cauterization, which we owe to Bloodgood has, in recent years, fallen somewhat into disrepute. There can be no doubt that, in the past, this operation has been practiced indiscriminately by surgeons with little experience in its specialized technique, and ignorant of its limitations. In a large group of giant cell tumors from the American Bone Sarcoma Registry analyzed by Simmons (5) some years ago the cures following curettage were 62 per cent only. I believe however that, in carefully selected cases, curettage should continue to be an operation of choice. For the indolent tumors it is, of course, an ideal procedure but, as already suggested, these are likely to be in a minority. The crucial test of the operation is its effectiveness in the early stages of rapidly growing tumors of moderate size even after actual perforation of the bone shell has taken place (Fig 13). The technique of curettage is discussed too rarely and, in consequence, there is a belief that the operation is a minor procedure. The removal of every particle of tumor tissue from the interior of a large bone cyst, the control of the resulting hemorrhage and the final systematic chemical cauterization of the whole tumor cavity is a precise technical performance, demanding both judgment and experience. The operation has too often consisted of a hasty "scrape"



Fig. 9.

Fig. 9. Case 3. Thirteen months after the astragalus transplantation. State of the tumor before deep X-ray therapy was begun.



Fig. 10.

Fig. 10. Case 3. Seventeen months after astragalus transplantation. State of the tumor after deep X-ray therapy treatment.



Fig. 11.

Fig. 11. Case 3. One year after treatment of recurrent tumor by excision combined with radium implantation.

and a perfunctory sponging of the bone cavity with carbolic acid. It is not surprising that many failures are on record.

The selection of curettage as the operation of choice should be determined, not only by the size and type of the tumor but by the anatomical situation. In regions where a local resection can be performed without undue mutilation, this procedure should be definitely preferred to curettage.

In certain tumors of the lower end of the femur and upper end of the tibia (the classical sites) where there would be no difficulty in eliminating all traces of tumor tissue the thickness of the barrier which separates the tumor from the cavity of the knee joint is the deciding factor. For during an efficient curettage there is a risk that a fragile shell may be cracked or perforated on its articular aspect.

The dangers of repeated curettage are now well appreciated. If local recurrence follows a primary curettage the second operation should be either resection or amputation according to the anatomical indications.

The effective scope of curettage has undoubtedly been extended by the use of post operative irradiation. In the tumors analyzed

by Simmons, the cures following the combination of curettage and irradiation were 72 per cent. My own experience of this technique though comparatively small, is encouraging. I have had one striking example of the value of radium implantation following incomplete curettage and chemical cauterization in a large hemorrhagic giant-cell tumor of the hum which had burst through its bony shell. This was a tumor which, on the earlier histological findings was at first regarded as a true sarcoma (4). This patient is alive and well 10 years from the time of operation.

In tumors in certain less accessible situations curettage followed by repeated courses of deep X-ray therapy, is an admirable substitute for the more mutilating alternative of excision. I have one such case under observation at the present time—a giant cell tumor of the head and neck of the femur—which appears to be undergoing progressive healing (Figs. 14 and 15).

2. **Excision.** As an operation of the first instance, excision is chiefly applicable in tumors of the upper limb where excellent function may be preserved after resection of the ends of any of the major long bones, with the

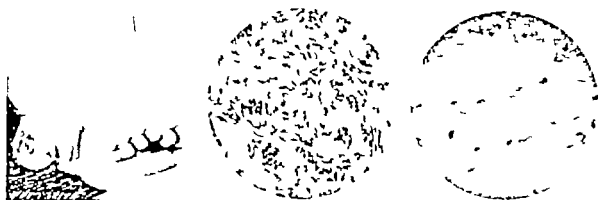


Fig. 22 Giant cell tumor lower end of tibia in a female aged 42 Showing fungation of the tumor through the skin

exception of the lower end of the radius (Figs. 16a and b). If it is considered advisable that the resulting loss of bone should be made good by the insertion of an autogenous graft, it is wise to postpone the reconstructive operation until it seems certain that local recurrence is unlikely (see Case 3).

In the *lower limb* there are few opportunities of practicing resection, except in tumors in unusual sites, such as the fibula or head of the femur for which curettage is considered to be impracticable.

Compared with curettage the operation of excision gives a much higher percentage of cures—in the series already referred to (Simmons)—the ideal figure of 100 per cent.

3. *Amputation* Little need be said on the general subject of amputation in the treatment of giant cell tumors. In the *lower limb* the operation is inevitable in neglected tumors in the region of the knee which have progressed to the stage of advanced destruction with impending invasion of the knee joint, and in certain tumors which have recurred after curettage or have defied irradiation. In tumors of the lower end of the femur or upper end of the tibia, which can be cured only by curettage and cauterization at the expense of the integrity of the knee joint, the operation may be desirable at an early stage. In patients of middle age the economic advantages of amputation are considerable and the loss of a limb is a small price to pay for the elimination of a tumor which is obviously a menace to the patient's life.

PRIMARY IRRADIATION

It remains to consider whether there is any justification for the use of primary irradiation as a substitute for operation in tumors which are still amenable to conservative operative attack. In the uncommon giant cell tumors of the *flat bones* e.g. the ilium, where curettage may be of doubtful efficacy and complete excision impracticable irradiation is the only form of therapy available. But the deliberate choice of irradiation as a primary measure in tumors of the long bones is often, in my judgment a somewhat hazardous experiment. There is not only the obvious objection that, in the absence of histological evidence derived from a biopsy the diagnosis may remain in doubt. Still more important is the difficulty which arises in connection with the interpretation of the clinical, and more especially the radiographic, signs of healing in a tumor undergoing irradiation. The appearance in the roentgenograms of zones of bone sclerosis at the periphery of the tumor though suggestive of bone repair is not convincing proof of the death and obliteration of the tumor cells *en masse*. There is also the potential injurious effect of prolonged irradiation on articular cartilage to be reckoned with. If the penetration is sufficiently powerful to kill an osteoclastoma of the lower end of the femur or upper end of the tibia, the knee joint is bound to suffer. This objection applies equally to the use of irradiation after the operation of curettage. For this reason, as a general rule, the use of postoperative deep X-ray therapy should be

confined to tumors in situations such as the hip, where ankylosis may be far less disabling than the functional results of a resection of the upper end of the femur.

I believe that valuable time may be lost in waiting for a tumor to heal under irradiation. It is not sufficient for the radiologist to claim that the tumor is held in check over a long period. If irradiation is to compete on even terms with the conservative surgical procedures, there must be convincing evidence in a short period of time of shrinkage of the cyst and obliteration of the cavity by new bone without the clinical signs of deterioration of the joint in the neighborhood of the tumor. These points are illustrated in the following case of my own series.

CASE 4. Male, aged 56 years. Giant cell tumor of lower end of femur, right.

The patient suffered a contusion of the right knee followed by a localized cystic expansion of the external condyle of the femur. Operation was not advised and a trial of irradiation was suggested. Three courses were given over a period of 15 months. During the early stages the tumor was believed to be under control, but during the last 6 months the knee became steadily more swollen, more painful, and fixed.

On examination June 4, 1934, there was found a well marked enlargement of the external condyle of the femur with local tenderness, distended veins, the knee practically fixed in 15 degrees flexion, marked wasting of the thigh.

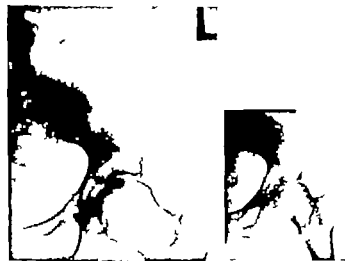


Fig. 14, left. Giant cell tumor head of femur in a female aged 17. Pre-operative X-ray.

Fig. 15. Giant cell tumor head of femur in a female aged 17. Eleven months after curettage and cauterization, followed by deep X-ray therapy. Appearance suggests obliteration of the tumor.



Fig. 13. An active, rapidly growing giant cell tumor of the lower end of the femur in a man of 30 with early perforation of the bony shell and treated by curettage and cauterization. Shows condition 5½ years from the time of the operation.

X-ray examination January 3, 1933, made after the original injury (Fig. 17) showed localized eccentric cystic expansion of the external condyle with clear cut boundary and coarse trabeculation.

Figure 18, a roentgenogram taken May 6, 1934, shows the cystic area much increased in size.



Fig. 16. a, Giant cell tumor lower end of ulna, in a female aged 25. Treated by resection. b, Specimen after excision.

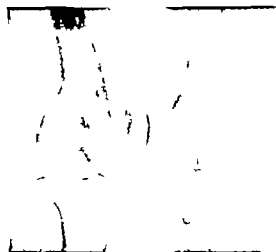


Fig. 7. Case 4. Giant cell tumor lower end of femur in a male aged 56. Trabeculated cystic expansion of the external condyle with a fairly thick shell.

attenuation and partial disappearance of the bony shell a line of fracture through the upper part of the cyst.

On June 10, 1934, a midthigh amputation was performed.

Description of specimen. (1) A cystic expansion of the external condyle, with an absence of bony shell on the superficial aspect. Contents of cyst, tissue of varied consistency and color. Small amount of fluid present. (2) The knee joint showed erosion of the articular cartilage on the adjacent surfaces of the external condyle and tibial tuberosity with a strong adhesion binding the two surfaces together. *Joint almost completely fixed.*

Histological examination of the contents of the cyst revealed a typical benign giant cell tumor with no suggestion of malignancy. spindle and round cells with marked number of giant cells, particularly in relation to large areas of hemorrhage.

Here is a giant cell tumor occurring in a man of 56 years (an unusually late age) which increased in size in spite of irradiation. When first discovered the tumor could undoubtedly have been cured by curettage with the pres-



Fig. 18. Case 4. The same cyst fourteen months later, after irradiation showing considerable increase in size and attenuation of the bony shell.

ervation of a useful knee joint. Fifteen months later when a surgical opinion was sought the advanced destruction and the degenerative changes in the knee joint made amputation inevitable.

I believe it is not unreasonable to regard the case for primary irradiation as still *sub judice*. My own experience leaves me at the present time an advocate of early operative intervention. On this important aspect of the giant cell tumor problem however my mind is still open and to let.

REFERENCES

1. GOSCHICKER, C. F. and COVELAND, M. M. Arch Surg 930, 20 713
2. Idem Arch Surg 1930 2 145
3. KIRO, E. S. J. Brit J Surg, 1933, 20 78
4. PLATT, H. Proc Roy Soc Med (Sect Orthop) 93 85 1-42.
5. SIMMONS, C. C. Surg. Gynee & Obst 1931 53 469
6. STEWART, M. J. Lancet, 9. 4. 2 1236
7. Ibid 1922 1106 Proc Internat Cancer Confer ence 926, July

Discussion

FREDERIC J. COTTON, M.D., F.A.C.S., Boston. Somehow the age discrimination seems less clean cut in our experience than in Mr. Platt's. We have seen a good many typical giant cell tumors in children, a good many cysts in adults, which by no means are always to be connected with lime abnormalities or parathyroid activity. One recognizes, of course the odd solitary cysts encountered in adolescence. These are obviously dystrophic, but their origin is not clear. A parathyroid background has not been established in my cases though to be sure many of them antedate modern exact chemistry.

The giant cell tumor is however a distinct entity and, as Mr. Platt has said, of varying type as to growth rate (therefore as to bone expansion) and as to tendency to recur.

The arch type is the tumor para-epiphyseal later in a bone end, it may show some bone expansion, characterized by irregular outline particularly by apparent trabeculation, and by a tendency to involve progressively all parts of a given bone. Involvement of the soft parts or of the adjacent joints occurs late if at all.

There is definite evidence to support the statement that giant cell tumors do degenerate to form cysts and transitional forms are not rarely met with.

Some confusion may arise here because real cysts of any origin may show in the lining membrane giant cells in some number. Giant cell tumors may be associated with cysts in the same individual—both of obvious parathyroid background. On the other hand giant cell tumors which do not become cysts or retrograde into scar fibroma, may and seldom do recur even after excision by a technique or dinarily efficient; they may very rarely give rise to chest metastases of similar apparently non-malignant histology.

It must be remembered that these giant cells are the bone eaters and that their presence in granulation tissue—for that is the mass of the tumor—may prove only the destruction of bone. They may well

be as Mallory has called them, only "foreign body giant-cells" though this hardly explains similar tumors, as epulis or tendon sheath growths.

There is no question but that there is a definite class of giant cell growths. They are essentially benign, and usually can be diagnosed by means of the X-ray. It is true that these tumors and certain cysts have much in common in appearance and in origin.

I agree with the speaker that operation is absolutely preferable to irradiation. I would go even further and say that irradiation usually acts to stimulate the tumor growth; the curative effect beginning only later and at the expense of unnecessary deformity from loss of bone.

Only when such tumors are found in the spine (recognizable in part by the characteristic invasion of the transverse and other processes) is the X-ray to be chosen as a means of treatment. Elsewhere thorough curettage and vaseline packing to allow healing from the bottom gives permanent cure in most cases.

We have seen several cases in which patients have remained cured, at least for years, after a second operation.

We have seen one case recur after 2 years' apparent healing, reoperated upon, and become apparently well after a year; recurrences are usually rather prompt.

If a third operation is necessary, it should be resection.

We have data on but one amputation; amputation should have been done in one other case with repeated recurrence and final death from thoracic metastasis.

I am much interested in Mr. Platt's 40 year limit. One recalls in this commonwealth very, very few cases of giant cell tumors after 40 and based on the age of the patient there seems to be no exact or even nearly exact differentiation between giant cell tumors and their near cousins, the "solitary" cysts.

ENDOCRINE MECHANISMS IN CERTAIN FUNCTIONAL GYNECOLOGICAL DISORDERS¹

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NO apology need be made for discussing functional disorders before an audience of surgeons, who in the popular mind at least, are the artisans of the medical profession. Certainly in gynecology more than in any other branch of surgery an ever increasing proportion of our patients invoke the science as well as the art of our calling. If I may very immodestly quote from a previous paper of my own "If the proper study of mankind is man the proper study of gynecology is woman in all her varied biological aspects, rather than merely as a creature possessing pelvic organs of certain shape, size and position. To achieve such breadth of viewpoint a knowledge of the more static subjects of the anatomy histology and pathology of the generative organs must be supplemented by a familiarity with the physiological and endocrinological forces which vitalize these organs.

The approach to clinical problems of the gynecologist interested in endocrinology is apt to be very different from that of the man so unfortunate as never to have interested himself in this new and fertile field. To the first such a symptom as uterine bleeding may mean a careful search for anatomical causes, and if none are found an assumption of functional or perhaps even "idiopathic" etiology. His more physiologically minded confrère however tries to go a step further and, knowing something of the normal physiological forces tries to determine what the nature of the functional upset may be. Again where one type of gynecologist will open the abdomen with an eye only for structural deviations, the other includes in his survey, a consideration of such physiological factors as may often be deduced from careful inspection of the ovaries, coupling with this the information gained from a careful history and a really comprehensive physical examination which must often include all the interlocking ductless gland structures. Innumerable examples

might be offered in support of this general thesis, and some I shall have occasion to stress later in this paper. One need no longer fear that an interest in endocrinology will expose one to the criticism of being a ductless gland faddist, and it is no mere literary overstatement to assert that a working knowledge of endocrinology is indispensable to the gynecologist who would practice his specialty intelligently.

To argue that our knowledge of gynecological endocrinology is very incomplete and that the subject is a bewildering one to the neophyte or for that matter even to investigators who have worked intensively in this field is merely begging the question. A sufficient number of facts have been crystallized out to change and to freshen our viewpoints on many old problems in both reproductive physiology and clinical gynecology and this modicum of knowledge it is not difficult to acquire. The disappointments of organotherapy should be no deterrent, as seems to be the case with many. Nothing can be much more certain than that the brilliant advances of reproductive physiology will bring their therapeutic reward in the not very distant future but we need not wait for this, to develop an interest in endocrinology. Even in its present undeveloped state it can aid much in the interpretation of clinical problems, and can make our daily work as clinicians much richer in interest and zest.

THE NORMAL CYCLE

It goes without saying that a discussion of the endocrine mechanisms in gynecological disease presupposes some knowledge of the endocrine mechanism of the normal genital cycle. A still broader knowledge will come from a study of this phenomenon from a comparative standpoint. This is not the place to review the normal physiology of menstruation. I have done this in several previous publications. As a basis for our discussion of

pathological physiology, however it may be emphasized that the rôles played by the two known ovarian hormones are now rather clearly defined. One of these hormones the hormone of the graafian follicle (estrin theelin, folliculin, "the female sex hormone" or menformon) exerts two chief effects upon the endometrium, and to a less extent the uterine musculature, viz. growth and hyperæmia. This hormone is produced not only in the developing follicle but also as we now know, in the corpus luteum which supersedes the follicle after extrusion of the egg. The more characteristic hormone of the corpus luteum progesterin, is, on the other hand responsible for the secretory changes of the premenstrual or preovulatory phase of the cycle—changes which are indispensable for the implantation of the fertilized egg.

MENSTRUAL BLEEDING

With reference to the hormone mechanism of the actual bleeding of menstruation the evidence now indicates that the responsible factor is an abrupt drop in the blood level of folliculin so that in the failure of pregnancy, the built up endometrium is suddenly deprived of its sustaining force and undergoes degeneration and desquamation with probably both a rupture and an increased permeability of the blood vessels as immediate causes of the menstrual bleeding.

I have thus briefly and baldly stated this concept of the dominant rôle of estrin with drawal in menstrual bleeding, it is supported by a wealth of evidence and is accepted by almost all of the best investigators of the problem though some recent studies of Smith and Engle throw some doubt on the correctness of this view. If it is correct, a flood of light is shed on the mechanism of a number of functional disorders familiar to all gynecologists.

FUNCTIONAL UTERINE BLEEDING

Perhaps the most important of these is the very common and often very distressing functional hemorrhage so characteristically seen in women at or near the menopausal age on the one hand, or during the pubertal or early adolescent years on the other, though not infrequent at any age during the reproductive

epoch. The bleeding in these cases may be very severe or even exsanguinating even though the pelvic organs be grossly normal.

In so far as the ovarian hormones are concerned, the mechanism of this disturbance seems now to have been clearly established. The important defect appears to be a failure of ovulation, so that the follicle continues to develop beyond the normal ovulation period, and what is most important, to produce a steadily increasing amount of estrin. So long as the endometrium is being thus supplied, it continues to grow, and bleeding does not occur. Clinically we know that such patients often exhibit non bleeding phases of even many weeks, so that, with the final onset of free bleeding, there is not infrequently and not unnaturally a suspicion of early abortion.

The endometrial picture. The endometrium subjected to such persistent and excessive estrin influence undergoes a slow vegetative proliferation, assuming the appearance for which, many years ago I suggested the designation of "swiss-cheese pattern." This I believe to represent what is essentially an enormously overdeveloped basalis, for it is the latter endometrial stratum which is most receptive to the growth effect of estrin.

There are, however, all gradations of this proliferative type of endometrium. In the most extreme forms, the endometrium is grossly, enormously overgrown and polypoid, constituting the condition formerly, and erroneously, designated as "polypoid endometritis." In other cases, the endometrium shows little or no gross increase and may even be quite scant though the histological pattern may be the same. With reference to the histological appearance, similar variations are encountered from the extreme swiss-cheese pattern with its large cystic glands side by side with those of normal caliber, to those in which the endometrium resembles that of the normal interval phase, with few or no enlarged glands. The important feature, however, is that neither on histological study nor on differential staining (for glycogen) is there any evidence of secretion in the gland epithelium, for progesterin is lacking, the follicle having persisted without ovulating and with absence of the corpus luteum as a result.

Why there should be these great differences in the grade of proliferative picture encountered in cases of functional hemorrhage I do not know. The first thought would be that the intensity and duration of the estrin stimulation is the determining factor but this does not seem to be borne out by the clinical study of these cases. Whether the degree of receptivity of the endometrium is responsible or whether some as yet unknown interaction of the ovarian and anterior hypophyseal sex hormones must be invoked remains to be seen. The possible rôle of the rate of excretion from the body of the causative hormone or hormones must also be considered, though since the bleeding and the histological picture in the endometrium are local phenomena in that tissue I do not believe that the factor of excretion rate can explain these local variations.

The pathologist who expects to see a typical *swiss-cheese* endometrial pattern in every case of functional hemorrhage is apt to be disturbed if he finds only a proliferative picture scarcely or not at all distinguishable from that seen in the early interval phase. Instead of straining his eyes to look for an occasional dilated gland to justify him in the diagnosis of hyperplasia, he need only recall that, just as the interval pattern is that of the *basalis* raised to a somewhat higher power so is the *swiss-cheese* hyperplasia pattern only a still higher power of the interval picture. The term hyperplasia is a misnomer in not a few cases both from a gross and microscopic standpoint. A better plan would perhaps be to designate such endometria merely as proliferative, estrous, or hyperestrous, the inference being that we are dealing with a purely estrin produced picture.

Some authors have reported the finding of premenstrual secretory endometrium in cases of functional bleeding. Since no hormone except that of the corpus luteum can produce these secretory changes, this finding at once removes such cases from the category under present discussion, though they may possibly still be of functional nature. To put it another way there is little doubt that other factors than hyperestrogenism may at times produce excessive bleeding even with apparently

normal organs, though my experience leads me to believe that this group is a small one. That the uterine musculature may at times be at fault, with the production of a genuinely myopathic bleeding seems probable though it is difficult to prove. The same may be said as to a possible rôle of the vascular and vasomotor systems, or for that matter of the nervous system in general. We are in almost complete ignorance of these cogs in the menstrual machinery our knowledge of the latter being almost entirely limited to its endocrinology and histology.

In the occasional case in which a secretory endometrium is found in association with supposed functional hemorrhage my own reaction has been to suspect the correctness of the diagnosis and to bear in mind the possibility of some not easily discoverable structural lesion such as a submucous myoma, a uterine polyp or a low-grade chronic pelvic inflammatory disease. This is not to deny the possibility of functional hemorrhage due to other causes than the persistent unruptured follicle, especially as we know too little of the possible rôle of other endocrine glands, such as the thyroid, in this connection. Occasionally though not often functional bleeding is clearly due to hypothyroidism and readily cured by thyroid medication.

Pathological physiology. To revert again to the pathological physiology of the common type of functional bleeding I have already stressed the fact that so long as the endometrium is receiving a steady supply of estrin bleeding does not occur. How then can we explain the bleeding phases, sometimes short, more often prolonged, often periodic, not infrequently very irregular not rarely continuous? On the basis of what is now accepted as to the hormone mechanism of menstrual bleeding in the human female, or of estrous bleeding in some of the lower animals, the obvious explanation would be that the estrin blood level undergoes drops at varying intervals, and that it is this estrin withdrawal from the endometrium which is responsible for the bleeding.

What explanation however can we make as to these intermittent drops in the estrin level? For this we must turn to the reciprocal

relations existing between the ovarian and anterior hypophyseal sex hormones. While it is true that the anterior pituitary lobe is the "motor of the ovary," and that failure of anterior pituitary function means a failure of ovarian function it has been established that the ovary in turn exerts a reciprocal effect upon the anterior lobe. The work of Moore, Hisaw and his collaborators, as well as other investigators, has shown that prolonged and excessive estrin administration is followed by inhibition of the anterior lobe function and that, with the latter in abeyance, there follows an inhibition of ovarian activity.

In our cases of functional bleeding a similar mechanism seems to operate so that when the estrin level reaches a certain point there is produced an anterior pituitary inhibition and in turn an inhibition of follicular activity in the ovary with the drop in estrin which is responsible for the bleeding phase. I have compared the mechanism to that employed in our automatic heating systems in which the production of heat is automatically shut off when the temperature of the house reaches a certain level. The interlocking relationship between the two glands is thus seen to be not only qualitative, but also quantitative, and this is true of endocrine relationships in general, a fact often overlooked.

As to the local or anatomical findings in the bleeding phase with which we are not directly concerned in this paper suffice it to say that there is no such extensive desquamation as is seen during menstruation although small, localized infarct like areas of necrobiosis are commonly seen. Schroeder believes that these small areas are the source of all the bleeding an explanation which, to me has never seemed to carry conviction. It is difficult to believe that such tiny areas could give rise to the very massive hemorrhages sometimes observed especially in view of the moderate bleeding characterizing normal menstruation where practically the entire surface is lost. Some other factor, such as increased permeability of the blood vessel walls and increased diapedesis must be invoked to explain the bleeding from a surface which grossly, at least, often appears quite intact. The histological picture during the bleeding phase, in so far

as the swiss-cheese pattern is concerned, is quite similar to that seen in the non bleeding phase, there being no such histological cycle as occurs in normally menstruating women.

So far I have discussed chiefly the ovarian hormones as direct causes of this disorder. In conformity with the general subserviency of the ovary to the anterior lobe, there can be no doubt that the underlying cause is to be sought in the latter. The prolan A principle is obviously the dominating one concerned as it is with follicle ripening and the production of estrin. The absence of corpora lutea in the ovary would indicate a lack or deficiency of prolan B, the luteinizing principle of the anterior lobe, if we accept the concept of the duality of the two principles. The fact that some excellent physiologists believe that it is the luteinizing principle which is also responsible for ovulation would explain the failure of ovulation in cases of this type. On the other hand, the recent studies of Kurzrok suggest that prolan A is the factor concerned with ovulation if the finding of prolan A just before the ovulation time may be accepted as evidence to this effect.

Already there is a considerable body of experimental evidence to confirm the natural assumption of the underlying rôle of pituitary dysfunction as the cause of functional hemorrhage but when we try to seek even further, for an explanation of the pituitary disturbance, we meet the same stone wall which faces us when we seek for the underlying cause of menstrual rhythm and periodicity. The secret is still sealed within the pituitary, to which all evidence points as the ruler of this rather turbulent endocrine republic.

SOME ASPECTS OF STERILITY AND FERTILITY

Women who are suffering with functional bleeding associated with hyperplasia of the endometrium are characteristically sterile, for they do not ovulate. Furthermore, since there are no functioning corpora lutea in the ovaries, there is a lack of the progesterin so indispensable for the prenatatory changes without which implantation can not occur. And yet in many of the milder cases the bleeding is periodical like normal menstruation, and the amount of the flow may be only slightly above

normal. I emphasize this because it illustrates the fact that periodical bleeding not distinguishable clinically from normal bleeding may occasionally occur without ovulation. In the overwhelming majority of women, of course, the mechanism is of the well known ovulatory variety but the exceptions to this rule are, I believe more frequent than has been believed. My observations lead me to think that, even if menstruation is normal the non-ovulatory type of periodical bleeding is not rare in women near the two extremes of menstrual life when pathological function of bleeding is so often seen. A normal puberty presupposes a perfect conjunction of several endocrine phenomena, and this does not always occur. For example the follicle ripening mechanism may be operative before the ovulating and luteinizing effects are unlimbered and an anovulatory type of periodical bleeding clinically quite similar to normal menstruation may occur. This is an adequate explanation of the well known fact that nubility and fertility are by no means invariably synchronous.

As the woman approaches the time of actual menopause it is quite possible for the cycle again to revert to the anovulatory type the common estrin-progestin sequence being superseded by a purely estrin mechanism in so far as the ovaries are concerned. At any age during the reproductive epoch as a matter of fact, such a mechanism may develop and this possibility must be borne in mind in seeking for the cause of otherwise unexplainable sterility.

There has been much discussion as to whether the anovulatory type of cycle, admittedly the exceptional type in women is to be considered pathological. Differences in opinion on this point are explainable entirely by differences in the definition of menstruation. If the traditional definition of menstruation as a periodical discharge of blood from the uterine mucous membrane is accepted certainly anovulatory bleeding of the periodical type under discussion comes within this definition. If on the other hand one adds to the definition the requirement that ovulation and corpus luteum formation must occur it is obvious that anovulatory bleeding is always

pathological even though it clinically simulates normal menstruation perfectly.

Such a restriction of the definition reminds me of the rapid mental shift exhibited by the Turkish physician in a case quoted by Garriou in his *History of Medicine*. The patient was a Turkish upholsterer who during the delirium of typhus fever drank from a pail of pickled cabbage and recovered whereupon the Turkish doctor declared cabbage juice a specific for the disease. The next patient dying under this regimen however they modified the dogma by saying that cabbage juice is good for typhus provided the patient be an upholsterer.

My own viewpoint is that the time honored clinical concept of menstruation as a periodical uterine bleeding enunciated long before we knew anything of possible differences in its hormone mechanism, is the logical one to accept. Corroborative evidence of the two types of menstruation has been abundantly furnished by students of reproductive physiology in monkeys in which the cycle is so similar to that of women. The two types are seen not only in different monkeys but also in one and the same animal at different seasons of the year even though the menstrual flow itself shows no alteration in rhythm or amount.

OVULATION TEST

The occasional importance of the above facts in the study of our sterility cases is obvious. The question naturally arises as to whether or not we can determine whether the individual patient is ovulating. This can, I think, be unhesitatingly answered in the affirmative. The endometrium is the registering board of the two ovarian hormones, and we know the effects which each produces upon it. The ovulation test, as we designate it, consists simply in obtaining for microscopic examination a bit of uterine mucosa shortly before the expected onset of a period. If the woman has ovulated a corpus luteum has been formed in her ovary progestin has been secreted and definite secretory changes have been produced in the endometrium as can be determined by simple microscopic examination with occasional differential staining for confirmation.

If on the other hand, a proliferative, non-secretory picture is found, we may conclude that there is no corpus luteum and that ovulation has not taken place. I could cite a number of instances in which this test has proved of much value. For example, in a recent patient, aged 39, in whom both tubes were blocked at the isthmus, and in whom I had planned performing resection of the closed portions and tubo-endometrial anastomosis, the finding of a non-secretory endometrium just before menstruation prevented an operation which would undoubtedly have been useless.

Once again I emphasize that the anovulatory cycle is the unusual one in women, and that in the vast majority of women a secretory type of endometrium is to be expected just before menstruation. But in the comparatively small group of cases of otherwise unexplainable sterility, where tubal patency tests, endocrine studies, metabolism determination, semen examination, and other studies have failed to reveal a cause. I am inclined to think that as opportunities for observation increase, a not inconsiderable proportion may be explained by failure of ovulation. This is especially to be sought for if the menstrual periods are somewhat free and perhaps slightly irregular.

I emphasize once more the importance of microscopic study of the endometrium in the study of functional menstrual disorders, for this tissue is a mirror of ovarian activity, and we can often learn more from it than we can from blood and urine hormone studies, important as the latter are in many cases. The quantitative hormonology of blood and urine moreover, is impracticable in everyday practice, while valuable information is often obtained from the far simpler histological studies of the endometrium.

To obtain tissue from the uterus an anesthetic is not by any means always necessary, although this would be fully justified by the value of the information gained. In the majority of cases, however, specimens for study can be obtained without anesthesia either by using a curette sufficiently small to pass through an undilated cervical canal, or by some form of suction. During the past year

or so, I have been using suction by means of the electric motor pump the cannula for introduction being a modification of the Rubin insufflation cannula. More recently still, we have modified this by building a very small serrated curette on the open end of the cannula.¹ By means of this suction curette and the electric pump we can almost always obtain sufficient tissue without anesthesia for microscopic examination, and in some cases, in which the endometrium is sufficiently loose and fluffy, can perform a fairly complete curetting. The powerful suction engendered by this method is apt to cause some pain but this is usually easily bearable and the procedure requires only a few moments. After all, however, any method which will yield tissue sufficient for diagnosis, without pain to the unanesthetized patient, should be satisfactory. If light anesthesia is required, as is sometimes the case, there is no reason why the customary dilatation and curettage should not be carried out.

The rich possibilities of this suction or suction curette technique for the investigation of other intra uterine conditions may be mentioned in passing. I need only suggest that it will furnish an excellent means of studying the day to day variations in such conditions as amenorrhoea, in some of which at least, a histological cycle does occur, as I have found in a few cases. How does such a cycle differ from the normal and what takes the place of the bleeding phase? Again, if a sufficient number of such procedures are carried out, it seems reasonably sure that embryologists will be made happy by the accidental finding of fertilized eggs in earlier phases whether implanted or unimplanted, than the 9 to 11 day old Miller ovum.

Finally, as regards the anovulatory type of cycle, it should be added that this is only one of the endocrine mechanisms which may be concerned in sterility, though with the others there is often some manifest suggestion of endocrinopathy. For example in the far more common form of sterility associated with adipsogenital dystrophy there are present also amenorrhoea and a rather characteristic type

¹A description of this simple apparatus will shortly appear in the *Journal of the American Medical Association*.

appearance of estrin occurs during the menopause would confirm this impression although it has been shown that the climacteric is an epoch of changing blood and urine hormoneology with excess of estrin in some phases decrease in others, while in still others the chief feature is the excess of prolactin A. I have been impressed with the infrequency of troublesome vasomotor symptoms in cases of functional menopausal bleeding commonly accepted to be produced by hyperestrinism. It would be foolish to generalize on the basis of such observations, but the widely prevalent use of estrogenic substances in the treatment of the menopausal symptoms is certainly given a measure of support by this circumstantial evidence

OTHER INTERESTING ENDOCRINOPATHIES

Another though rather rare type of endocrine disorder in which I have been much interested is that observed in association with certain ovarian tumors which, among other endocrine effects, produce at times a remarkable change in secondary sex character. One not very rare group of tumors, the granulosa cell carcinomata exhibit a strong hyperfeminizing influence so that in children they bring about precocious puberty and menstruation while in elderly women they may produce an apparent re-establishment of menstruation. The opposite group the arrhenoblastomata, secrete the male instead of the female hormone and thus elicit phenomena indicative of masculinization and defeminization. These tumors, however constitute a story in themselves and one inextricably bound up with the still hazy story of sex differentiation in general so that this variety of endocrinopathy must be passed by with mere mention. For a discussion of the subject, the reader may be referred to the recent paper by Novak and Long.

I would have liked to discuss such interesting clinical applications of biological knowledge as are illustrated in the treatment of the gonorrheal valvovaginitis of children by the estrogenic substances and the treatment of undescended testis by the administration of the anterior pituitary like hormones of pregnancy urine. It might have been of interest,

too to discuss the diagnostic and prognostic application of the pregnancy tests in the management of hydatidiform mole and chorioepithelioma.

Another question inviting discussion is the possible application of the law of follicular constancy¹ as enunciated by Lipschuetz, in the explanation of the cystic degeneration of conserved portions of ovarian tissue, and perhaps the responsibility of pituitary dysfunctions of one sort or another for many cases of cystic ovarian degeneration. Certainly the histological pictures found in such cases are quite similar to those found in the ovaries of laboratory animals after injection of pituitary extracts of one form or another.

Finally it might have been of interest to include a discussion, though it must have been a speculative one about the reverse effects of pelvic anatomical lesions upon not only the ovarian but also the pituitary function. Certainly it is difficult to explain in any other way the disturbances of menstrual amount and rhythm which are so common with uterine myomata, ovarian tumors, chronic pelvic inflammatory disease and other pelvic lesions. A comprehensive survey of the functional disturbances would also have to include many cases in which definite anatomical lesions are present in the pelvis. I need cite only one instance that of ectopic pregnancy for without question the mechanism of the endometrial bleeding characterizing this condition is a hormonal one emanating primarily from the ectopic trophoblast. Many other examples might be discussed were there time for this.

EPILOGUE

While it is difficult to condense into a short summary the rather general discussion of endocrine relationships in which I have indulged I would again emphasize the patent indispensability of a knowledge of such matters to the gynecologist who would practice his specialty intelligently. An interest in endocrinology will change one's whole clinical viewpoint, and will freshen one's interest in many clinical problems which have threatened to become hackneyed and stale.

While our knowledge of the subject is still incomplete and in many fields only nebulous,

there is perhaps no branch of medicine in which such rapid strides have been made in such a short time. Thus far investigators have been studying chiefly the broad qualitative aspects of endocrine relationships but there is reason to believe that future work will reveal that endocrine equilibrium connotes a finely balanced quantitative relationship between the various endocrine organs. Another broad principle in need of elucidation is the rôle played by the variations in sensitivity of the recipient tissues to endocrine influences and the factors governing such variations for this seems just as important as the study of the endocrine dysfunctions themselves.

Discussion

DR. GEORGE VAN S. SMITH, Brookline. Dr. Novak's lucidity in dealing with these hormone mechanisms calls forth deep admiration on my part. His conservative but free thinking has been of real aid to us all in crystallizing our present knowledge.

Dr. Novak speaks of the sustaining force that estrin has in preventing the endometrium from degenerating and desquamating. In confirmation of this, it has been observed that very large amounts of estrin given just before menstruation have resulted in a lessened or even a scanty flow. Furthermore, the more or less intact estrous endometrium of typical dysfunctional bleeding supports the idea of the sustaining ability of estrin. However our knowledge of what happens at the time of conception, and the ability of progesterin to prevent or stop bleeding in women or experimentally in monkeys, makes it necessary to consider the luteal hormone a sustaining factor also.

I hesitate to complicate by theoretical considerations the clear description that Dr. Novak has presented of the endocrine situation in endometrial bleeding but feel that a few points might be brought out to demonstrate that the picture is not yet complete.

Hæmorrhage into the follicle ruptured by ovulation is well known. Careful studies show that at the time of ovulation there is actual extravasation into the endometrial stroma and occasionally blood is passed from the uterine cavity. Could this bleeding be due to a drop in the level of estrin? It does not seem so since estrin is known to be on the increase at this time.

If endometrial flow is the result solely of the removal of the two sustaining factors, estrin and progesterin, why is it that other animals with regular ovulatory cycles do not show this phenomenon? Dr. Novak has found evidence of an ovulatory cycle in women with amenorrhoea by histological studies of the endometrium and we have demonstrated the same thing by the finding of cyclic rises and drops

Many other fields of investigation, rich in promise to both scientist and clinician, lie before us. The laboratory investigator must bear the brunt of the burden but the clinician can be if he will a valuable co-worker rather than a mere parasite. This is possible only if he has prepared his mind by familiarizing himself as fully as possible with what has already been accomplished. His insight into his clinical problems will be clearer and deeper if he views them with one anatomical and one physiological eye, harmoniously co-ordinated so as to bring these problems into sharper focus than it is possible to do in another way.

in the excretion of estrin in a woman with complete amenorrhoea of 3 years' duration. That actual ovulation occurs is proved by the fact that these patients do become pregnant. Why do they not bleed? Conversely why do both women and monkeys at times menstruate (I use the term guardedly) without previous ovulation or corpus luteum formation and when they do so would one not expect the flow to be excessive and prolonged? Furthermore as Dr. Novak points out, excessive bleeding may occur in patients whose endometria do not show marked estrin changes. My object in raising these points is to stress Dr. Novak's feeling which we also share that a drop in the level of estrin cannot be the only precursor of bleeding and that we must seek another factor or combination of factors in order to explain these discrepancies.

In support of this idea of another factor or combination of factors as a cause of bleeding *per se* we have obtained, with the urine of a large proportion of patients with dysfunctional flowing a prolan A effect in immature rats, using amounts which would give negative results if they came from normal women. And almost consistently has this effect disappeared with the cessation of bleeding following treatment with the urinary prolan of pregnant women. These findings, together with the estrin drop can be considered advancing steps in the gradual elucidation of the bleeding mechanism.

At present we decidedly agree that microscopic study of the endometrium gives much more reliable information than quantitative hormone analyses do. A critical experimental study of the existing methods for extraction and biological assay of prolan and estrin in the blood and urine of non-pregnant subjects has convinced us of their inadequacy. We do not feel that we can determine even approximately the amount of prolan A excreted by a patient. Until recently we thought we had been estimating urinary estrin with a fair degree of accuracy, but now we find that the simple expedient of boiling urine with

concentrated hydrochloric acid gives values up to 10 times higher. We are thus hopefully struggling for refinements in quantitative methods and anticipate discovering in this manner much more than it is possible for examination of the endometrium alone to reveal.

I am much intrigued by the finding of a cyclical increase in weight in relation to menstruation. Weight increases have been observed in cases of migraine before attacks, at which time urinary prolan A has made its appearance. In view of the recently discovered hormonal changes in certain toxemias of pregnancy I am of the opinion that the edema seen in these conditions often has a hormonal background.

Allow me to emphasize Dr. Novak's exhortation that even in its undeveloped and apparently complex state present-day knowledge of these mechanisms is not difficult to acquire and can add much to the interpretation of clinical problems.

DR. JUK VINCENT MEXIS, Boston. We have been privileged to hear Dr. Novak present a most interesting, entertaining, and thorough paper on a very difficult subject. It is probable that many have understood all he has related but it is more probable that some have not. The latter is not due to Dr. Novak's lack of clearness but is due to a lack of understanding of the terms used and the complexity of the problems. Most of us who are working in this field and have a satisfactory knowledge of the terminology must stop and think over his reasons for believing as he does. If certain phenomena that we have all noted in our work could be explained by some of his theories, then we should have a more intelligent conception of his subject. For example he has spoken of endometrial biopsy, and we have noted in our work in the Ovarian Dysfunction Clinic of the Massachusetts General Hospital that this slight operation upon amenorrhoeic patients is sometimes followed by a menstrual period. If this is true we may assume that ovulation has taken place (an observation first brought to our attention by Burch) and it should follow then that some of the pregnancies noted after the Rubin test and after lipiodol injection of the uterus and tubes can be explained. For if ovulation takes place in certain instances after instrumentation of the uterine cavity conception might perhaps occur. It has long been noted that after a dilatation and curettage of dysmenorrhoeic and amenorrhoeic patients the patients' periods become more regular and less painful, and that fertility is raised. Perhaps instrumentation of the uterine

cavity by restoring ovulation and normal menstruation, is responsible for some of our successes.

Again it has been noted by all of us that after a thorough curettage of the patient with abnormal uterine bleeding a normal menstrual rhythm frequently follows. This may be due not so much to the curettage and removal of the hyperplastic endometrium as to some stimulation of the pituitary gland and through it of the ovary causing a normal rhythm to follow. Many practitioners often ask why it is necessary to give radium and X-ray treatment or to operate upon patients with abnormal bleeding, since curettage has cured so many. We who are surgeons and users of radium are often at a loss to explain some of the excellent results in patients treated in this simple manner. It is quite probable that the stimulation of the endometrium or uterus may restore normality to the pituitary and ovary and therefore put an end to the abnormal bleeding. The mechanism whereby ovulation occurs following instrumentation is not clear at present, but it is interesting to note that the female rabbit ovulates only at the time of coitus and that pseudopregnancy with corpus luteum formation follows in the mouse after copulation with a sterile male.

Dr. Novak has stated that one type of abnormal bleeding is due to continuous estrin production and that there is frequently a persistent follicle and absence of corpus luteum formation. There can be no doubt of the truth of the statement, for all of us have noted these findings during pelvic operations. If the persistent follicle (usually a small cyst) is removed, normal menstruation will be resumed. It has been suggested that rupture of such a cyst during bimanual examination might restore menstruation. Such a maneuver has been described and advocated in the literature and in my practice I have noticed its effect on two occasions. It would be hazardous to advocate such a procedure but it is evident from this discussion that removal or rupture of a persistent cyst containing estrin causes the normal rhythm to be resumed and therefore Dr. Novak's explanation of such bleeding cases is certainly upheld.

There are many other practical applications and many other observations that come to our minds as we master the knowledge of what has already been worked out by men interested in endocrinology. Dr. Novak is certainly one of the foremost among such investigators and his paper this evening demonstrates his great knowledge of the subject. I would like to thank him for all I have learned from his talk tonight and from the study of many of his excellent publications.

THE UNSOLVED FRACTURE¹

KELLOGG SPEED M.D., F.A.C.S. CHICAGO ILLINOIS

BEFORE this body of surgeons, bound by clinical ties the selection of a talk on fractures should cover a practical subject which might suddenly be of interest to any one of us. The unsolved fracture is chosen for discussion because it is the major peripheral fracture of our skeleton, and because for more than a century its treatment and the results have been a matter of controversy and inquiry among surgeons and because although the results obtained today show improvement, they are not at all comparable to those of other fractures. The progress in the investigation of fracture of the neck of the femur has been along many lines which can merely be mentioned here without discussion of their details. The collection of studies and statistics gradually increases in our surgical literature, reports for the most part being based on observations and research in anatomy, physiology, pathology, roentgenology and treatment, including end results. Appended to this paper is a list of recent articles.

One hundred years ago the difficulties in treatment of this fracture which was recognized as of major importance and had already invoked years of study, were discussed by Sir Astley Cooper in his work on "Dislocations and Fractures of the Joints." He said in part "In the examinations which I have made of transverse fractures of the cervix femoris entirely within the capsular ligament I have only met with one in which a bony union had taken place or which did not admit of a motion of one bone upon the other. I believe the reason that fractures of the neck of the thigh bone do not unite is that the ligamentous sheath and periosteum of the neck of the bone are torn through, that the bones are consequently drawn asunder by the muscles and that there is a want of nourishment of the head of the bone but I can readily believe if a fracture should happen without the reflected ligament being torn that as the nutrition would continue the bone might unite,

but the character of the accident would differ, the nature of the injury could scarcely be discerned and the patient's bones would unite with little attention on the part of the surgeon."

In 1834, there were claimed to exist 19 specimens of healed fracture of the neck of the femur in the various museums of the whole of Europe including the 3 of Malgaigne at the DuPuytren museum and Tilanus 3 at the Hospital of St. Peter at Amsterdam. Hamilton was inclined to doubt the authenticity of some of these specimens and believed that many of them were the results of old rachitic or other deformities. Some of these doubts were later sustained by Basset and aired in his monograph. It was further stated by Hamilton before 1880 that the number of specimens to be found in American museums was probably as great as all those in Europe and he advised that treatment "ought to be directed to the retention of the bone in place, by suitable mechanical means for a length of time sufficient to insure bony union or for so long a time as the condition of the patient will warrant." He employed a long side splint with extension of 10 pounds applied by adhesive tape to prevent eversion of the limb but failed to employ any abduction.

Anatomical study of the neck of the femur has been directed along the lines of the architecture of the lamellar construction of the head and neck in relation to the trochanteric portion of the bone in weight bearing axis to obtain a more or less diagrammatic viewpoint of how the angulated neck carried the superimposed body and yet permitted freedom of motions in the hip joint. The internal arrangement of the bone is found to conform to the requirements of these two purposes and to fit in with the general supporting trabecular scheme of the pelvis as carried up to the spine. Another most important point has been an acceptance of the idea that the blood supply of the head and neck comes from 3 sources (1) through the ligamentum teres the arteries

¹ Fracture Orations presented before the Clinical Congress of the American College of Surgeons, Boston, October 3-10, 1914.

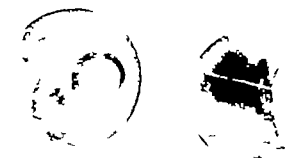


Fig. 1. Head removed November 4, 1931, 13 months after fracture with non union. The dark areas show bone of original density as of the time of accident, now aseptically necrotic. The lighter areas represent efforts at bone replacement and revascularization. The cartilaginous rim seems quite intact without pitting. On the neck surface is found bone absorption and wearing away of osseous structure. The finer details and macroscopic findings have been given in other articles.

of which are shown by Chandler and Kruesscher to be present in nearly all individuals (2) the periosteal vessels and (3) capsular branches of the anterior and posterior cervical arteries. We have also come to believe that there is some extension of blood vessels through the epiphyseal plane into the head from the superior nutrient artery.

Physiological investigation has been directed toward the changes in this part of the bone during adolescence and senility and their relation to bone repair after fracture. Study of sections of the femur confirming old observations demonstrate that in senility the canal



Fig. 2. A postmortem specimen removed 4 months after fracture treated in the conventional manner. Imperfect apposition of fragments was evidently obtained with slight rotation of the head, but very little evidence in the gross specimen of any mal-position. The main portion of the head seems alive with some lighter areas around the rim as of bone replacement but no true bony union has occurred and no effort at new bone formation has started from the trochanteric fragment. The angulation of the trabecular lines at the fracture plane and the loss of density in the trochanteric portion of the bone are apparent. The specimen does not show definite bone replacement as starting from the vessels entering via the foramen which may have been occluded or of minor caliber yet the head is not dead en masse. No weight bearing had ever been permitted so that factor of pressure is eliminated. Note the intact cartilage. Non-union to a live head.

openings in the bone enlarge in diameter especially in the neck where the cortical shell of bone is the thinnest, but contrary to previous understanding according to Radasch the

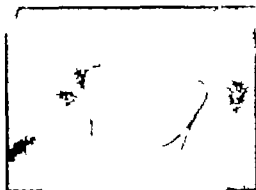


Fig. 3. Left figure, reduced fracture of neck in a large heavy woman, 73 years old, in the conventional position and plaster dressing, May 2, 1931. The head appears viable. Right figure, same hip May 17, 1933. The patient had 18 weeks in plaster then wore a walking caliper for 7

months. The head still seems viable and the union at the neck holding. She was continued on the caliper 3 additional months and now has satisfactory functional use of the joint with no further bony changes. Union to a live head.

amount of organic material in the bone slightly increases in ages from 60 to 90 years. The average adult has 39 to 40 per cent of organic material in his femur whereas in advanced age a proportion as high as 42 per cent is maintained. The cause of fragility in old bones cannot then be ascribed to their loss of organic material with resulting change in the elasticity required for resistance to stress but must lie in the change in porosity and thinning of the bony wall, which overbalances any gain of organic material. Although repair by callus after fracture will be attempted in this senile bone, the effort must represent a distortion of ordinary healing inasmuch as the regressive changes incidental to age still go on and two conflicting processes are at work.

No accepted evidence has been offered of the exact physiological nature of the changes affecting the epiphyseal area before the occurrence of separation of the epiphysis in adolescents to prove that it is directly based on local or constitutional disease. Many instances occur in fat youths but no definite relationship between thyroid, hypophysis or other endocrine disturbance accounts for all cases. Some have shown pre separation changes betrayed by a luckily made X ray examination, or symptoms of slight pain or lameness have existed prior to separation. Mild trauma or muscular action can be traced in the final cause of nearly everyone



Fig. 4. Hip of a young man 8 years after traumatic epiphyseal separation at the neck of the femur replaced accurately immobilized 16 weeks, and supported with a walking caliper 10 months. He had grown 8 inches in height following the separation with $1\frac{1}{4}$ inches shortening in the injured leg; very good final painless function; range of motion in joint restricted about 50 per cent. The head has broken down with flattening and abundant new bone has formed in the neck. Union to a head undergoing late aseptic necrosis with deformity and joint changes involving the acetabular surface.

A glimpse at the reported investigations of local pathology betrays the great interest in this phase of the fracture. Most important have been the findings in the hips of patients on whom operation was performed and the relatively scant postmortem material obtainable. The amount of tear in the capsule of the joint—rarely complete,—the character of the fracture plane, and especially its reduction and the rapid loss of bone substance in unimmobilized or reduced cases has been watched

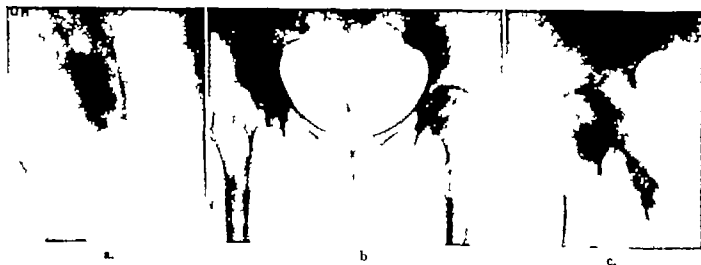


Fig. 5. a, Impacted fracture of left neck before reduction in a heavy woman 55 years old. Manipulative reduction 5 days later on February 17, 1933. She had walked on the fracture several days and had considerable pain. Head seems viable and somewhat rotated. b Same, both hips May 18, 1933 after conventional 18 weeks in plaster. Head

appears viable and firmly united. One year later walks very well, slight pain but no change in roentgenological findings. c, Lateral view this hip June 26, 1933. There appears to be every evidence of fair position of the head and bony union to a live head. Had been walking on caliper more than a month.



Fig. 6. Heavy male, 40 years old, 6 months after an attempted fixation of neck fracture. The trochanteric portion of the bone was pushed up by weight bearing on an unrecognized fracture and lay completely posterior to the head. Operation for bone graft into the head was planned and started. Difficulties in freeing the trochanteric fragment and hemorrhage led to shock and abandonment of operation when only a side-to-side contact had been obtained. This film represents the condition 6 months after removal from plaster and after weight bearing in a walking caliper. He has no pain, a fair range of motion, and no change in position. Apparently a union by lateral contact only without proper apposition of viable head.

The principal points of interest have been in the behavior of the head of the bone after fracture the changes developing in it or its covering cartilage resulting in interference with blood supply aseptic necrosis, revascularization and substitution for dead bone by newly formed bone. Studies have also been made of resulting changes in cartilage of the head of the femur and the acetabulum involving slowly progressing loss or deformity of cartilage over areas of dead bone with replacement by bone from the subchondral areas, or complete collapse depending on the length of time or the amount of unwise weight bearing permitted after fracture. Observation of patients over long periods of time coupled with roentgenological investigation has advanced our ideas of prognosis and treatment and supplemented the information gained in other branches of the study. The fate of the head separated from the neck, or attached to it in proper approximation can be followed and foretold largely by its complete or partial change of density as compared to neighboring bone. This information however still leaves something to be learned about the fracture. One cannot say in the early weeks after fracture, even in an average adult or adolescent to say nothing of a senile person whether the

head in a given case will die and yet unite to the neck, or live and unite and later break down to flatten and slowly disintegrate, after hope had been advanced of a perfect restoration. It is this great uncertainty of the fate of the head and its subsequent mechanical changes which hold this fracture in the unsolved class.

From the studies of Santos, Phemister myself and others, it is known that 4 general results are to be obtained—a dead head with no union or a real union (which is rare) a live head with no union, or a non union (which is far from uncommon). In his recent report Phemister states that he has seen 49 patients at varying periods after fracture, following different methods of treatment, of whom 17 had heads which were alive, 8 with union, 9 with non-union. There were 32 cases of complete or partial necrosis of the head with union present in 4 and non union in 28.

Pleat formation and other cartilage changes incidental to disease as described by Freund are not found after fracture, but replacement of cartilage and finally pannus formation with adherence of the head fragment in the acetabulum are seen. True ankylosis of the hip joint has been found after a healing of the neck of the femur.

Roentgenological investigation has covered a study both of the patient's bone *in situ* and of the specimens removed, coupled with the summary of the pathology and histology present. The most recent X-ray advance has also done much from the popular standpoint to influence treatment.

Every surgeon should know however that not only the amount of union between head and neck can be shown on the X-ray film but that even more important information can be conveyed. The film must show both hip joints and the adjoining parts of the pelvis. The amount of regional atrophy about the fracture, a natural sequence of the injury and loss of activity the changes in the head showing by retained original density or by mottling whether the head is entirely or partly dead or is undergoing bony replacement, along with changes in configuration indicating flattening or collapse or cartilage changes may all be read from one film. The future of the fracture from the standpoint of union to live or dead

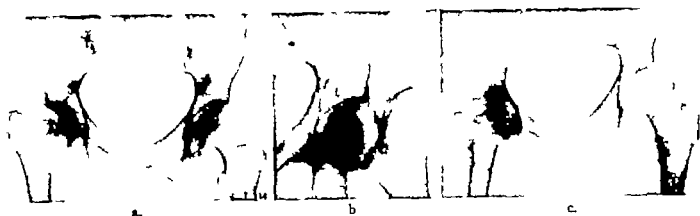


Fig. 7 a, A 57 year old woman with fracture of neck of the femur in a limb the site of an old infantile paralysis. Manipulative reduction attempted 3 weeks after accident followed by the conventional period in plaster. Only fair apposition was obtained. b Same hip 8 months later. After removal from plaster had been walking in caliper

with very little weight bearing. Non-union to dead head betrayed by the relative densities of the bone fragments. c, Same patient after a Whitman reconstruction operation had been performed. A fair functional result was obtained in this patient considering the defect in the leg from a former paralysis.

head, or a hopeless outlook which might be bettered by operative procedure of fixation or reconstruction, can be thus exposed in a series of films taken at intervals after treatment is started.

Rigorous analysis of films and results obtained by reduction or operations and careful clinical examination after months of supposed perfect reduction lead to the development of roentgenological technique for lateral views of the head and neck of the bone. The surprising result was that there had been as high a percentage of functional use and slight disability as had been found in the average case because glaring deficiencies in angulation or approximation of bony surfaces were exposed. However union was found in some instances in which complete or perfect approximation had not obtained—a condition known to exist in many fractures throughout the body.

An understanding of my title lies in a review of the care of this fracture the mechanical treatment of which was put on a rational basis by Royal Whitman 45 years ago. His suggestions have only slowly been adopted by the surgical world more rapidly in Germany than in France and England. In the United States every effort has been made to teach the basic points in the last generation, but there is still woeful lack of application of the principles laid down by him. Traction on the leg, inversion followed by abduction, are not universally used, partly because of lack of interest among many men handling these fractures and partly

because these same men including many surgeons who receive patients with this fracture do not know how to apply a comfortable lasting and serviceable plaster dressing with the patient in the position of reduction. There is no excuse for this lack of treatment ability since, through Hawley's ingenuity we have been given the fracture table. For that matter a proper plaster-of-Paris dressing may be applied by use of a simple padded perineal post on the edge of a table with the patient lying on an inverted bowl as was done 30 years ago.

Failing on account of some of the points mentioned in preceding paragraphs or for other unknown reasons to get union in a satisfactory percentage of instances surgeons turned to operative attempts to force the fracture to heal or to remove the head as advised by Sir Robert Jones. In 1902 Murphy began nailing on the heads of femora. Delbet perfected his screw and hip guide a few years later and there has followed a series of different operative attempts some with some without opening the hip joint all aiming at close and exact lasting approximation of head onto neck. Ivory and bone transplants into the head via the trochanters, nails, special screws the Smith Petersen flanged nail and lately nails or screws applied along guide wires inserted through the trochanteric portion of the bone under fluoroscopic guidance—devised by Sven Johansson, Jerusalem, and others—are all being tried. Hillebrand has reported

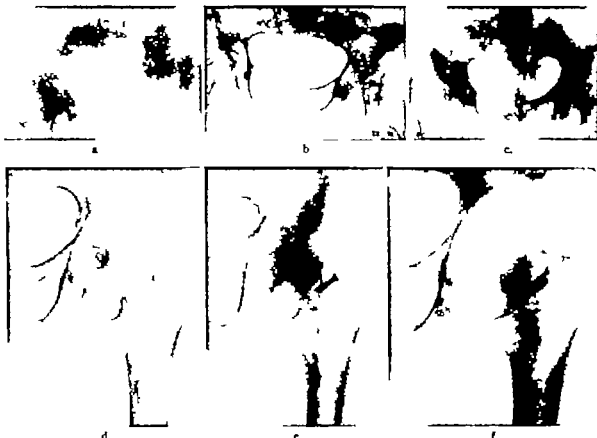


Fig. 8. a, Fracture of neck in a 35 year old woman. Seen, reduced, and put in plaster within 2 hours after accident, December 10, 1931. b, Same patient, both hips in plaster December 1931. c, Replacement, apposition, angle of neck, all seem good. d, Same hips April 1932 just out of immobilization. e, Apparently good union to live head. f, Same fractured hip June 6, 1932. Union good and head viable but neck seems to bend a trifle. Has never borne any unsupported weight, worn caliper constantly. g, Same

hip September 1, 1932. Evidence of bone absorption upper edge of neck. Head outline good, union persists. h, Same hip November 1, 1932. Head mottled a little as if bone replacement were going on in it. Neck a little depressed with evidence of absorption spots upper edge. g (See opposite page). Same patient, both hips, December 1, 1932. Has constantly worn caliper and not returned to work. Head fragment definitely depressed and denser than that of other femur. Outline slightly oval.

favorably on the Hotz-Richard method of nailing through neck of the femur into the head and on into the pelvis. For delayed union Hey-Groves advises taking the head out and bolting it on by a bone peg before reinsertion in the hip joint violating one of the sacred sources of blood supply to the head via the ligamentum teres.

Manipulative reduction with subsequent plaster-of-Paris dressing has held the most adherents and has shown in statistical review of well handled series of cases by such men as Stern, Henderson, Campbell, and others, good results in from 60 to 70 per cent of the cases. Cotton has amplified manipulative reduction

by artificial impaction to drive the fracture surfaces together with a hammer striking on the trochanteric area in the axis of the neck after approximation of fractured surfaces. In spite of these methods of treatment, the percentage of unions with retention of live heads in patients surviving taking all ages into consideration does not satisfy Darrach and Stimson, in a series of their cases found by checking with lateral roentgenograms a high percentage of inaccurate appositions which they feel may explain an unsatisfactory percentage of bony unions heretofore obtained.

Union to a live or dead head does not always follow the quite exact approximation which

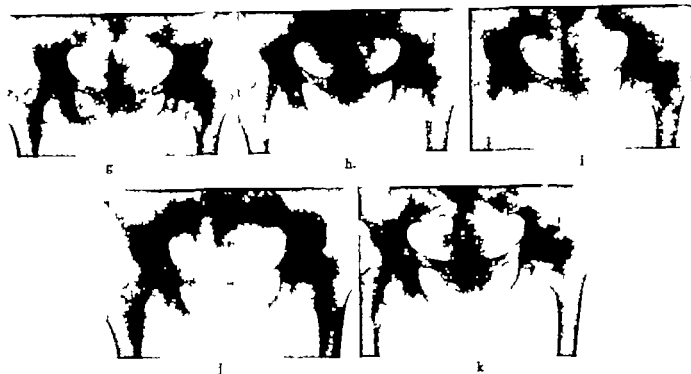


Fig. 8 continued. b Same hips March 1, 1933. Increasing depression of head and neck, with mottling union still present. i, Same hips September 1, 1933. Head has increasing density and is flattened. Union persists. Caliper removed as patient refuses to wear it longer. Cannot work and walks with limp but has no pain. j Same hips December 4, 1933. Neck flattened down to a right angle. Considerable restriction of motion in hip joint with definite shortening of leg. k, Same hips September 17, 1934, with

further progression in neck and head flattening, fragmentation of head, increased density and dead head. Union still seems present. Pain and disability continue, patient persuaded to resume caliper again. Were changes in head due solely to vascular failure or to pressure reaction? The early prognosis of the fracture this patient suffered had been good, that is, as of union to a live head, but the life history of the fracture in 3 years has proved to be just the reverse.

must be aimed at in every case, whether obtained by manipulative, artificially impacted or operative means. When the head gives warning that it is to die, becoming aseptically necrotic in part or completely, one cannot wonder at failure of union, no matter how exact is reposition. In some individuals the trauma of fracture, the loss of or even temporary interference with blood supply add weight to the destructive processes already set up in senile bone, upsetting its physiological equilibrium and leading to its necrosis with subsequent absorption when the patient survives. It would be expected that these factors would not affect the proper healing of adolescent bones which are still in bone building health with senile changes not expected. Yet some instances of this fracture in relatively young individuals lead to dead head and non union, in the adolescent, death and degeneration of the head—in appearance strikingly similar to Legg Perthes' disease—may come on months after an apparent bony healing of

epiphyseal separation. These changes have occurred when apposition of fracture surfaces has been most satisfactory, they are evidently either an expression of further progress of the unknown pathological changes present in the epiphysis before the separation, possibly leading to changes comparable to those of senility or of too early functional use of the newly healed bone.

Weight bearing or pressure which exists on the head of the bone from the very moment of reduction or continues on the active process of attempted bone healing is the one factor which seems understandable as leading to delayed non union, aseptic necrosis of the head, and deformity of the hip with joint changes. If we concede that it is largely pressure which causes absorption of the neck after untreated fracture, a similar pressure may act untowardly after reduction with Whitman's method by too early display of force against the capital portion of the bone as yet unable to withstand it on account of internal vascular changes. It



Fig. 9 a, Recent fracture of neck, July 19, 1928, in a 53 year old woman. This occurred during an attack of sleeping sickness. Exact date was concealed by attendants as she may have been allowed to fall out of bed. Head appeared viable compared to the other femur. b, Same hip, December 5, 1928. Operative reduction was performed; the edges of the two fragments cut back with a chisel and surfaces fitted together in exact apposition under the eye. Eighteen weeks in plaster followed, then walking in a caliper. c, Same hip, February 3, 1929. Head appears viable and union firm. Joint space seems narrowed but function very good. d, Same hip, January 9, 1932, at least 3½ years after fracture. Solid unyielding union to live head. If a bone transplant, screw or device other than simple replacement after freshening had been employed credit for final union and live head might have been given the internal splint. This case makes one doubt the necessity and possibly the value of any mechanical internal fixation.

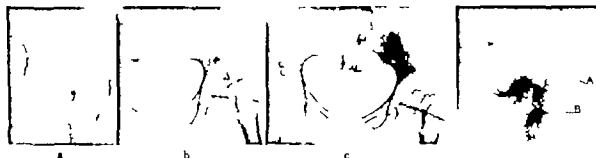


Fig. 10 a, Neck fracture September 6, 1933, in a young woman 19 years old 7 months after injury. She had been given 6 weeks' immobilization in plaster. Non-union to a live head with much pain and disability. b, Same fracture after operation, June 20, 1934. Surfaces had been freshened and held by autogenous bone graft. After 18 weeks in plaster she was allowed to walk in a caliper. Head alive, union apparently promised. c, Same neck, August 24, 1934. Union seems sustained, no depression of neck, head viable, bony trabeculae developing across fracture plane. Still wearing caliper. Prognosis very good. d, Lateral view of the preceding figure same date, August 24, 1934. A indicates healed fracture plane and B the imbedded transplant.

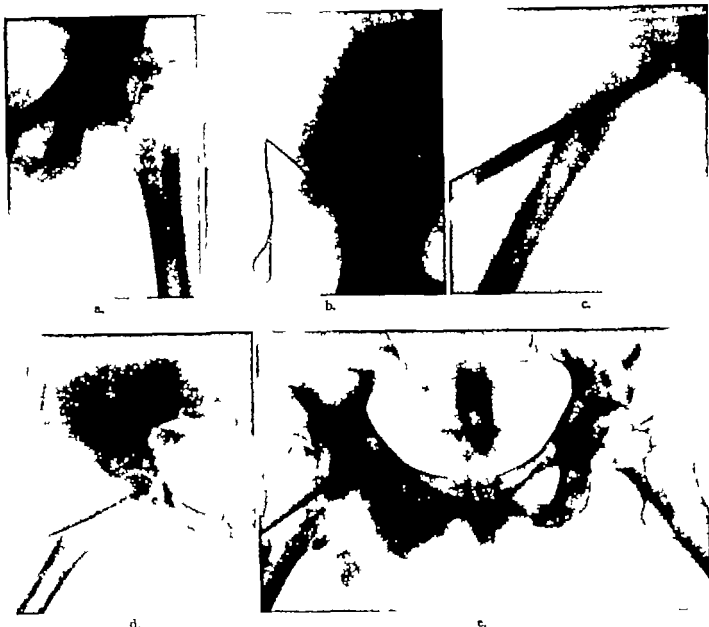


Fig. 11. a, Fracture of neck 5 months old in a heavy woman of 49 years, May 12 1934. She refused offers to be put in plaster with reduction in January 1934. Non-union pain, never been out of bed. Visibility of head questionable. b On operating table May 25 1934. Through a small anterior incision hip joint opened. Fracture site exposed and freshened. Reduction and abduction. End of a small flexible probe introduced between fracture surfaces as guide to drill for hole to carry transplant. c, Same date as preceding, still on Hawley table. Using probe as guide, the drill has been inserted below the greater trochanter and advanced across the fracture plane, striking the probe, to enter the head fragment which can be seen and felt to move

impaled on the end of the drill. d, Same date after operation, encased in plaster of Paris. Bone transplant taken from the tibial cortex (which seems very thin here, probably on account of the preceding 5 months in bed) has been thrust into the head along the drill tract. Position satisfactory. e, September 25 1934. Just out of plaster after 18 weeks. Position same as at operation, head a little mottled, union seems started at least, as there is evidence of callus at fracture plane. Was this all due to the implantation of the bone? Will the head retain vitality or will it go on to a complete replacement, and for how many months or years must weight bearing be guarded?

is also possible that too early or too great pressure, as from unguarded weight bearing in walking, interferes with the long period of time required for the return of the bony lamellae to their full maturity—a time varying with different individuals—and leads to a

reversal of the healing process and an absorption with necrosis of the bone. Some of these changes are irreplaceable either by time or method of treatment, including greatly prolonged freedom from weight bearing, but not from active motion which is no doubt beneficial



Fig. 2. Left, 3 years after fixation of recent neck fracture in an elderly woman, patient of Dr. Hugh McKenna. Union to a live head seems present. Right, 4 years later. Union has broken down and flattened. Cartilage collapsed, bone transplant still unabsorbed, but wedged to rest of femur. Did transplant cause original union? Did it interfere with circulation in the head, coming from the ligamentum teres? Did the head die and fragment on account of weight bearing after several years?

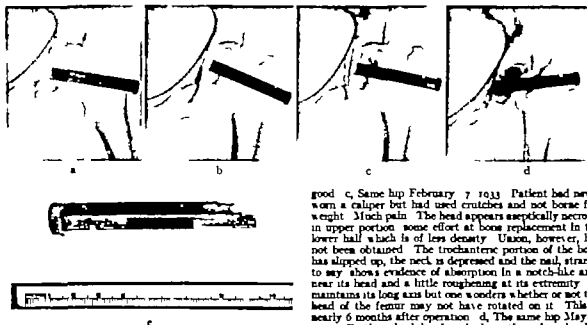


Fig. 3. a, Repair of fracture of neck in a woman 53 years old, by means of the Smith Petersen nail. The fracture occurred August 27, 1933; nail was inserted August 24, 1933. From the service of Dr. Phemister at the University of Chicago Clinics. b, Same patient. This film taken when plaster was removed on October 26, 1933. Apposition, angle of neck and penetration of nail all very good. Head appears slightly denser than surrounding bone with well-rounded outline and not spotty. Prognosis

good. c, Same hip February 7, 1935. Patient had never worn a caliper but had used crutches and not borne full weight. Much pain. The head appears aseptically necrotic in upper portion, some effort at bone replacement in the lower half which is of less density. Union, however, has not been obtained. The trochanteric portion of the bone has slipped up, the neck is depressed and the nail, strange to say, shows evidence of absorption in a notch-like area near its head and a little roughening at its extremity. It maintains its long axis but one wonders whether or not the head of the femur may not have rotated on it. This is nearly 6 months after operation. d, The same hip May 1934. Further dead head and absorption of neck. Increased absorption of the nail, elevation of the trochanter non-union to a dead head. e, Nail removed from patient. Its absorption and partial disappearance affect its stability as a fixation agent to a certain extent. If the circulation in the head has been so poor that death of it resulted, was change in nail caused solely by mechanical stress, or by action of cells or chemical agents in blood serum? Lowering of blood supply after fracture in the head in living human may not be so great as we suspect.

The average percentage of union is probably higher than it was 100 years ago but in comparison to practically all others this fracture remains unsolved. Our organization might advantageously provide for a corps study of this lagging fracture. Such a study should lead to the adoption of a more or less orthodox line of care for the recent fracture consisting of gentle reduction by traction, inversion and adjustment of the trochanteric portion of the femur to fit its displacement, followed by abduction to the degree indicated in the pre-reductive roentgenogram as necessary to restore the angle of the neck and coaptation of fractured surfaces. This reduction would be maintained by immobilization in plaster of Paris. Such a method would be practiced by most surgeons. A few might prefer to treat their patients by operation very soon after fracture employing selected methods in an attempt to minimize the period of immobilization and to avoid feared complications. All methods should be subject to proper X ray control for position and progress of healing. The convalescent period must be guarded by adequate support of the fracture plane not only during the healing and re-forming of the bone of the neck but also during the first months after release from immobilization when weight bearing is begun. At the present time there is no guarantee of 100 per cent cure. The secondary changes in hip joint and femoral head still occur, caused possibly, by vascular deficiencies or other unknown factors following even in the face of most satisfactory replacement and apposition by any method in vogue with a supposedly proper period of immobilization and freedom from weight bearing. Apparently they are immediate results of the fracture or its treatment but they seem uncontrollable by present methods of care. The fracture is still unsolved.

BIBLIOGRAPHY

1. American Orthopedic Association, Report of Commission of J. Bone & Joint Surg., 1930, 13 966.
2. ARCHAQUEM G. Necrosis of the proximal fragment in fracture of the neck of the femur, and its influence on the hip joint. Arch. f. klin. Chir., 1912 120 325.
3. BASSSETT ANDREWS. Les fractures du col du femur. Ann. clin. chir. du Professeur Pierre Delbet, Paris. Librairie Felix Alcan. 1920.
4. BOHANN E. J. A new treatment of intracapsular fractures of the neck of the femur and Legg Calvé-Perthes disease, technique. J. Bone & Joint Surg. 1932 14 884 1934 16 75.
5. BURNELL, STERLING. A slight for accurately directing dowel peg. Surg., Gynec. & Obst. 1933 57 685.
6. CAMPBELL, W. C. Central or intracapsular fractures of the neck of the femur. Proc. California Acad. Med. 1931 April 1932 July.
7. CHANDLER, S. B. and KREUSCHER P. H. A study of the blood supply of the ligamentum teres and its relation to the circulation of the head of the femur. J. Bone & Joint Surg., 1932 14 834.
8. COTTON, F. J. Intracapsular hip fracture. J. Bone & Joint Surg., 1934 16 105.
9. Idem. Artificial impaction in hip fractures. Surg. Gynec. & Obst. 1927 45 307.
10. DARRACH W. and STRIMON B. B. Displacements in fractures of the neck of the femur. Ann Surg. 1934, 100 833.
11. EISENBERG C. F. and LECOCQ J. F. A probable birth fracture of the neck of the femur. J. Bone & Joint Surg. 1933 15 1010.
12. FERGUSON H. B. and HOWORTH M. B. Slipping upper femoral epiphysis. J. Am. M. Ass. 1931 97 1867.
13. FREUND E. Active and passive pleat formation of joint cartilage. Arch. Path. 1934, 18 186.
14. Idem. Aseptic bone necrosis. Arch. f. path. Anat. etc., 1926 261 1.
15. Idem. Changes in the head of the femur following fracture of the neck. Arch. f. path. Anat. etc. 1930, 277 326.
16. Idem. X ray study of aseptic necrosis after fracture of the neck of the femur. Chir. d. organ. d. mov. mento 1931 16 223.
17. GILL, H. B. Treatment of fracture of the neck of the femur. Ann. Surg. 1932, 96 1.
18. HAMILTON I. H. Practical treatise on fractures and dislocations. 6th Am. ed. 1833.
19. HENRY M. O. Intracapsular fractures of the hip. J. Bone & Joint Surg. 1934, 16 168.
20. HIX-GROVES, E. S. Treatment of fracture of neck of femur etc. J. Bone & Joint Surg., 1930, 12 1.
21. HILLERBRAND H. Treatment of fracture of neck of femur by the Hotz femopelvic screwing method. Beitr. z. klin. Chir. 1933 157 266.
22. JAMES, S. A. Displacement of upper epiphysis of the femur. J. Bone & Joint Surg., 1931 13 856.
23. JOHNSON C. R. A new method for roentgenographic examination of the upper end of the femur. J. Bone & Joint Surg. 1932 14 859.
24. JONES, ELLIS. Trochanteric transplantation in the treatment of fractures of the neck of the femur. J. Bone & Joint Surg. 1932 14 259.
25. JONES, LAURENCE. Intracapsular fractures of the neck of the femur. Ann Surg. 1933, 97 237.
26. KRAUTER, I. Osteosynthesis for fracture of femoral neck according to Sven Johansson. Zentralbl. f. Chir., 1933, 60 864.
27. LEADBITTER, G. W. A treatment for fracture of the neck of the femur. J. Bone & Joint Surg. 1933 15 931.
28. PHILLISTER, D. B. Fractures of the neck of femur etc. Surg. Gynec. & Obst. 1934, 59 415.
29. RADASCH, H. F. Senility of bone and its relation to bone repair. Surg., Gynec. & Obst. 1930, 51 43.
30. RIZZIO A. W. Fractures of the femoral neck. J. Bone & Joint Surg., 1931 12 819.
31. SAWTOW, JOSE V. Changes in the head of the femur after complete intracapsular fracture of the neck. Arch. Surg., 1930, 21 470.

- 32 Idem. Changes which articular cartilage of hip may undergo. *Surg. Gynec. & Obst.* 1932, 54: 650.
- 33 SWARTZ, E. H. The Smith-Lowrie splint. *J. Bone & Joint Surg.*, 1933, 15: 901.
- 34 SWARTZ, PETERSON, M. N., CAVE, E. F. and VAN GORDON, G. W. Treatment by internal fixation. *Arch. Surg.* 93: 715.
- 35 SPENCER KILLOON. Fracture of neck of femur: clinical criteria in prognosis. *Ann. Surg.* 93: 96: 951.
- 36 Idem. Locomotion after impacted fracture. *Ann. Surg.* 92: 79: 270.
- 37 Idem. Ununited fracture of the neck of the femur. *T. West. Surg. Ass.* 92: 8, p. 30.
- 38 STEARNS, W. G., REED, R. S., HIRSHMAN, C. H. and PARSONS, L. E. Treatment of intracapsular fracture, etc. *Surg. Gynec. & Obst.* 93: 53: 250.
- 39 WARDLE, E. N. Etiology and treatment of slipped epiphysis. *Brit. J. Surg.* 1933, 21: 313.
- 40 WRIGHT, H. H. A method for the internal fixation of transverse fractures of the femur. *Virgilia M. Month.* 1933: 50: 197.
- 41 WHITMAN, ROYAL. The abduction method. *Am. J. Surg.* 1933: 21: 335 also *Ann. Surg.* 1933: 201: 473.
- 42 Idem. Abduction treatment of fracture of the neck of the femur. *Surg. Gynec. & Obst.* 9: 8, 27: 578.
- 43 WILSON, P. D. Displacement of upper epiphysis of femur treated by open reduction. *J. Am. M. Ass.* 1934, 83: 1749.
- 44 WOLCOTT, W. E. Circulation of the head and neck of the femur. *J. Am. M. Ass.* 1933: 100: 27.

STERILITY WITH SPECIAL REFERENCE TO SURGICAL POSSIBILITIES¹

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Ver dulces nates venere ac premis natis (Virg. Aeneid. IV)

THERE have been efforts to divorce gynecology from surgery and surgery from obstetrics, but it has always been our opinion that obstetrics and gynecology should go hand in hand and that the practitioner of these subjects should be able to cope with any of the ordinary surgical complications which may arise in his practice. In other words, let not the women of the world be dependent for their consultants in obstetrics on practitioners who are gynecologists and who only do obstetrics in private practice. A great deal of gynecology is due to bad obstetrics and the good gynecologist may make the future confinement a safe procedure whereas the ignorant gynecologist may leave the organs in such a position that dystocia is bound to occur.

What is the surgical subject most allied to obstetrics? Some might say plastic vaginal work. We believe that the link between obstetrics and gynecology lies in the attempt to cure sterility. When this subject was chosen we found we were rushing into a hornet's nest, from which we were inclined to run for we were well acquainted with the Meaker clinic in Boston, but sterility has been our close study for upward of 25 years, so we decided to adhere to our decision.

It is not intended to go through the whole gamut of the subject: it is not intended to produce a bibliography: this is being done every day: it is hoped to deal briefly with certain aspects paying especial attention to the surgical side.

Sterility is a disease: it is a disease which can bring misery into the home. The craving for a child may become a worse disease than anything else in the world. A patient of ours has remarked: "I would not mind dying if I could only have a child."

It has been suggested that "after sterility" can be prevented by care in the premarital state: surely this must be so and if girls are taught the principles of health and hygiene the future mothers of the nation will be able to fulfill their duties. The man and woman about to marry should be taught what healthy marriage is: they should be given one of the simple and scientific books on the subject not some of the suggestive trash which is being published by even reputable firms at the present time. Ignorance of the sexual functions has produced in our experience much sterility.

A word only must be mentioned about contraception. When advice is sought on this subject it is given and a warning is uttered

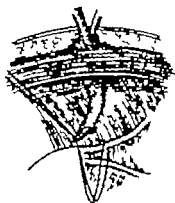


Fig. 1 Author's subperitoneal Gilliam operation, first stage.

about the possibility of sterility following the misuse of contraceptives.

A marriage should not be considered sterile until after 18 months. A woman should have no gynecological treatment for sterility (unless there are very definite other symptoms) until after 18 months. We agree with those writers who have found that about 30 per cent of cases of sterility are due to the male. In the male the most common causes are ignorance, impotence, excessive coitus, misuse of contraceptives, frigidity, and absence, paucity, or abnormality of the spermatozoa. As already stated it is not proposed to delve fully into all aspects of this subject. Suffice it to say that the sterile patient must be carefully questioned about her general health and her habits as well as her gynecological history. It would be an interesting study in this land of America to find the effect of alcohol on fertility: the sages of old were wise, and it may be remembered that the mother of Samson took a vow of temperance previous to the birth of her child. Are the babies stronger with or without Prohibition?

At a not very far distant date hormone therapy will be simplified. A separate paper could be devoted to hormone therapy in relation to sterility. The subject cannot be ignored nowadays. The effect of diet and thyrotropic hormones on the obese patient with scanty menstruation is dramatic in many instances. The diet without the drugs, or the drugs without the diet may be compared to the singer without the orchestra. At variance with other writers we have had much success in cases of hypofunction with scanty

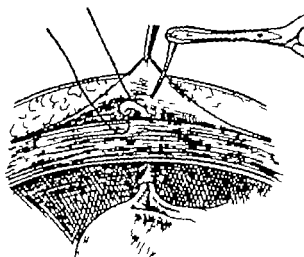


Fig. 2 Author's subperitoneal Gilliam operation, second stage.

menstruation by administering luteinizing hormones manufactured by one of the well known firms twice weekly for the first two weeks of the cycle followed by folliculin in some form in the last 2 weeks. Other writers have suggested other methods of dosage, and the matter is definitely *sub judice*. It is well that each investigator should give his own experience. Some measure of success has also been achieved by administering 6 doses of folliculin and then stopping apparently the sudden stoppage precipitates menstruation and makes an attempt to imitate the physiological cycle.

Laboratory work must seek the clue and solve the mystery of many a case of sterility. Constitutional ailments are excluded, and last but not least the gynecological surgeon is called in.

An intact hymen has been seen by the writer 11 years after marriage. A simple rupture under anesthesia will often cure the sterility. Rigidity and stenosis of the vagina, apart from hysterical vaginismus are well known causes. This can nearly always be successfully treated by thorough digital widening followed by the insertion of a large vaginal dilator, this is kept in position by tapes around the waist and is shown to the patient after removal. It has not been found necessary to perform plastic operations on the vagina. Such factors as the reaction of the vagina will not be dealt with here.

The cervix In order to cure sterility, writers have gone from one extreme to the other

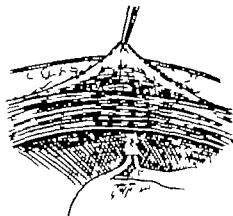


Fig. 3 Third step in author's subperitoneal Gilliam operation

Suggestions have been made by some that any manipulation of the cervix is futile by others that very radical measures are necessary. We have had in our own practice examples of pregnancy after the passage of the uterine sound and this is especially notable where there is a definite plug of mucus present—usually more than this is required. Dilatation of the cervix with some modification of Hegar's dilators or gradual dilatation by means of sea tangle tents is followed in numerous instances by pregnancy provided there are no other pathological conditions present.

It has long been a matter of dispute as to which of these latter methods is the better and we are so frankly agnostic that we use each procedure in 50 per cent of our cases with somewhat similar results. The great advantage in the tent method is that when the Rubin technique is used and the tubes are found to be normal no anesthetic is necessary for the introduction of the tent.

We have discontinued altogether all such operations as anterior division of the cervix, posterior division of the cervix, Pozzi's operation. We tried them for many years—a thorough dilatation is safer. Dilatation is continued until just before the start of tearing, i.e., until it is believed that the next dilator will tear the cervix. The danger of all such operations as those mentioned is that unless performed with meticulous care a scar will be left from which leucorrhoea may exude, a condition most inimical to the spermatozoa.



Fig. 4. Blowing up the fallopian tube with air.

The only other operations on the cervix worth mentioning are trachelorrhaphy to cure old tears in one child sterility and the removal of erosion by means of cautery or amputation. A careful operation to cure erosion will stop leucorrhoea and will often cure a long standing one or two child sterility.

The body of the uterus. Backward displacement of the body of the uterus is a very real cause of sterility. Such displacements as retroversion with acute antelexion and anteversion with acute antelexion are congenital malpositions associated often with hypofunction and dysmenorrhoea. Apart from dilatation of the cervix, no surgical measures are required; hormone therapy will help. The displacements which really concern us are retroversion usually associated with retroflexion with or without adhesions. The cure of these displacements often means the cure of sterility and a good prognosis may be given. To deal first, with retroflexion without adhesions, most of the women who consult us have no complaint except sterility. They are young women for whom pessary treatment is inadvisable. In fact very often the presence of the pessary acts as a bar to conception and operation is much to be preferred. Having done a Rubin test, followed by dilatation of the cervix, a subperitoneal shortening of the round ligaments is performed.

Since various operators seem to differ as to the best technique the operation is described and illustrated (Figs. 1 & 3). It is safe as to immediate and remote prognosis. It cannot cause intestinal obstruction or dystocia. It must be especially stressed that fine silk is used as recurrences have been encountered.

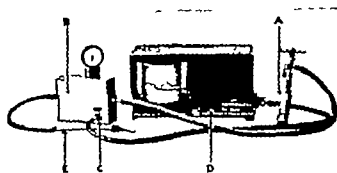


Fig. 5 Author's combined instrument for testing tubes and kymograph

after the use of catgut. The operation is done as follows

The abdomen is opened in the mesial line from the symphysis pubis upward. Adnexal abnormalities are corrected. A stitch of No 2 silk is placed about the round ligament on each side from 1 to 1½ inches (depending on the size of the uterus and the lengthening of the ligament) from the uterine cornu, this stitch is not tied, silk *must* be used, if catgut is the material, a recurrence of the displacement will occur. A clip forceps is placed on the edge of the rectal aponeurosis on a level with the top of the fundus uteri. A curved forceps is then passed under the aponeurosis between it and the muscle until it reaches the outside margin of the peritoneum. The forceps is then passed outside and behind the peritoneum and is brought inward until it reaches the stitch which has already been placed about the round ligament, it pulls this through. A Reverdin needle is then passed through the under surface of the aponeurosis at the outer margin of the rectus muscle, through the thickness of the ligament, and is threaded with one end of the ligature which is drawn through these structures, the same is done with the other end, and the stitch is tied. The same technique is carried out on the left side. The curved forceps may be passed through the internal abdominal ring, but there is no need to look specially for this point. The uterus is thus suspended in position by subperitoneal shortening of round ligaments, hence no danger of intestinal obstruction.

The silk is first steeped for 24 hours in ether and then for 24 hours in alcohol. After that it is boiled for 20 minutes and stored in 1:1000 mercuric perchloride.



Fig. 6 Author's ring forceps for control of ovarian vessels.

When adhesions are present, they are broken down. If the adhesions are complicated by tubo-ovarian trouble, these are dealt with. If the appendix is pathological, it is removed. The question of the removal of the appendix must be carefully considered. Appendicectomy in some unknown way has cured sterility or, rather, a woman who has been sterile has become pregnant after that operation. Whether the vestigial peritoneal band, the ligament of Clado which connects the appendix and right ovary has anything to do with this is quite impossible to decide. Appendicectomy raises the morbidity following gynecological operations, after manipulation on the tubes it is better to leave the appendix alone. Therefore the technique, if appendicectomy is contemplated, is that this organ should be examined and removed before any attempt at salpingostomy is made.

Apart from displacements, fibroid tumors will cause sterility, for they may act as mechanical impediments especially if in the neighborhood of the cervix or they may cause ovarian dysfunction. The gynecologist should spare himself no trouble to enucleate myomata, for their removal often means a sure cure of sterility. We have taken away a single myoma the size of a fetal head including portion of the uterine mucosa. We have removed multiple myomata and the results are very gratifying. It is very important in all cases to avoid the risk of intestinal obstruction. It is all important that postoperative adhesions should be avoided in case of sterility. Every effort must be made to have the uterine scar on the anterior surface of the uterus. If it must be on the posterior aspect, the scar should be covered with an omental graft. We do not suggest taking risks. If myomectomy appears in the opinion and from

the experience of the operator to be too great a surgical risk, hysterectomy must be chosen but the risk of labor after myomectomy need not be considered

Ovaries Ovarian tumors large or small should be removed when the patient is sterile. The sterile woman with mid menstrual pain associated with sterility can sometimes be cured of both by biannual bursting of the graafian follicle under anæsthetic. If this does not cure we have after laparotomy shaved the surface of the ovary and closed the abdomen. This seems to allow an easier extrusion of the follicle. We have performed ovarian grafting in a few cases of hypofunction in the hope that the graft would stimulate ovulation. So far we have had no cures of sterility in this type of case

Adhesions Special attention must be drawn to this cause of sterility. When there is no abnormality discovered on bimanual and tube examination and the husband and wife are both normal it is worth while to open the abdomen. Adhesions of the tube or ovary to the broad ligament or pelvic wall are sometimes present. Apparently the normal path of the ovum into the tube is interfered with. The separation of these adhesions is followed by pregnancy in a sufficient number of cases to justify the procedure

The fallopian tubes The question as to the advisability of operating on the fallopian tubes for sterility has been a bone of contention for many years. This bone has been nearly picked dry but as we are especially interested in this particular phase, we intend to try to pick a little more meat from it.

We do not intend to expound to any great extent on the anatomy of the tube but attention must be drawn to several points

1 The wall gets thinner as it is traced outward from the isthmus to the infundibulum at the same time the lumen gets broader. This thinness makes it easier to form a cuff in the tube during a salpingostomy at the fimbriated end, but sutures are a little more apt to tear out. The larger lumen makes pregnancy more likely here after salpingostomy

2 The interstitial portion of the tube contains more connective tissue and is therefore less elastic and possibly less favorable for

pregnancy than the other portions. The fact that there are two definite layers of muscle, the longitudinal and circular makes for no difficulty in resection.

3 A very important fact in anatomy is the arrangement of the mucosa in permanent long folds which are simple in their inner portions but become more and more complicated as they reach the fimbriae until their appearance simulates glands, but true glands are absent. In the event of a single inflammatory attack, the glueing together of the tubal walls becomes a very real possibility. It may be well to recall that Curtis some years ago showed that a slight manipulation in the cervix may produce a temporary infection in the tubes.

Cyclical changes in the tubes Novak and Everett have made this subject very clear and showed that the tube is derived from muellerian epithelium and takes part in the cycle of menstrual changes. It is especially noteworthy that the postmenstrual phase is characterized by low epithelium which quite rapidly increases in height. It seems therefore a favorable time for tube testing salpingography and salpingostomy

After these introductory remarks, we must consider how to deal with the diagnosis and treatment of the tube in its relation to sterility. In 1909 when our interest was aroused in the subject of sterility if a dilatation of the cervix or a dilatation of the cervix with curette failed to cure we could only recommend laparotomy in order to diagnose closed tubes in those cases in which palpation diagnosis was impossible. The abdomen was then opened. If the tubes were blocked, salpingostomy was done if they were patent they were blown up from the abdominal ostium with a large ear syringe (Fig 4). Pregnancy often followed. Now Rubin's great work on insufflation and salpingography has prevented the necessity for laparotomy in numerous instances in which it was imperative before.

It has been well said that there is nothing really new under the sun and without wishing to take the slightest credit from Rubin for his wonderful methods which have brought happiness to many a home the following quotation from the Aphorisms of Hippocrates, vol. ix, must be given

If a woman does not conceive, and you wish to know if she will conceive, cover her head with wraps and burn perfume underneath. If the smell seems to pass through the body to the mouth and the nostrils, be assured that the woman is not barren through her own physical fault.

This test seems to be the forerunner of the Rubin apparatus.

It is not intended to go into the details of the Rubin technique. We have followed his methods and got somewhat similar results especially with regard to pregnancies following both the inflation of the tubes with carbon dioxide and with ethidol. The latter has certain advantages over the other opaque substances in common use. It is thinner, seems to cause less pain, and requires less pressure to force it upward.

As we found that glass apparatus broke easily and was not really practical we had a tin box made with kymograph attached (Fig. 5). This kymograph does not give as complete information as Rubin's excellent instrument but it helps in giving confirmative information with regard to patency of the tubes or not. A very straight up curve means closure, a wavy curve means kinks, which can probably be overcome, a gradual curve nearly always means the tube will open at the second or third attempt. We have found especially that a round type of curve is often present in association with retroversion of the uterus. So far we have not been able to tell the site of occlusion except by definite salpingography.

If the tubes are apparently closed, the patient is left for from 3 to 6 months and if they are still closed laparotomy is advised. If laparotomy is to be done an X-ray photograph should be first taken. We use the simplest possible technique merely a Rubin sound with an attachment at the end in which a record syringe can be inserted and 9 cubic centimeters of ethidol injected. Sometimes after an X-ray photograph a Bonney sound is left in the cervix. When the abdomen has been opened if there is any difficulty in determining the site of closure the tubes are blown up with air from the vagina. Under what circumstances should salpingostomy be done? This question is best answered by the query: What are the contra indications?

1 The operation should never be undertaken in the presence of pyrexia, in other words, the infection should be chronic. Care must be taken to ensure that there has been no recent exacerbation of a chronic condition. We have had no trouble about this by adopting a routine sedimentation test in every case. The simple Linzenmeier technique is used, i.e., 1 cubic centimeter of blood is drawn into a syringe and mixed with a few drops of a 5 per cent solution of sodium citrate. If the blood settles in any time under 30 minutes the operation is not done.

2 If there is any likelihood of tuberculosis the operation should not be done. The presence of tuberculosis is difficult to determine. All efforts to obtain a history of tuberculosis usually end in failure. The patient refuses to acknowledge a tuberculous diathesis. A close inquiry into the family history may elicit the fact that the father, mother, or a brother or sister has suffered from the disease. Such signs as scars on the neck may help. Symptoms of tuberculosis of the tubes are more often absent than present, heavy menstruation is about the only notable feature. Such old tests as the Calmette and others were tried in many cases but they were found to be of little help. And even when the abdomen is opened, it is still impossible in a large number of cases, to say if the patient is tuberculous or not. The obvious cases speak for themselves, i.e., the mass adhesions, tubercles on the peritoneum, etc.

What should be done if the patient is known to be tuberculous? If there are masses of adhesions and tubercles pervading the abdominal cavity, if it is obvious that efforts to remove the tubes will cause escape of pus and leave raw surfaces difficult to peritonealize the patient should be left alone and radium or X-ray applied later to the abdomen if ascites or troublesome symptoms arise. If, on the contrary, the removal of the tubes will be a simple matter the idea of curing sterility is abandoned and salpingectomy done taking care to core out the interstitial portion from the uterus. In our early work, we tried salpingostomy for tuberculosis of the tubes, but never saw pregnancy follow in a single case known to be tuberculous. The radical opera-



Fig. 7 Catgut in tube after opening and oversewing ostium

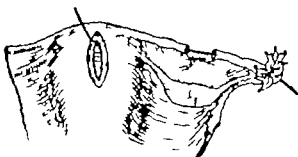


Fig. 8 Resection of isthmal portion of the tube

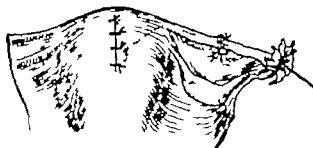


Fig. 9 Resection of isthmal portion of tube, operation complete



Fig. 10 Operation for disease at uterine end of tube and interstitial portion

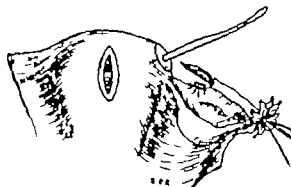


Fig. 11 Operation on uterine end of tube and interstitial portion, second step



Fig. 12 Operation on uterine end of tube and interstitial portion, third step



Fig. 13 Operation on interstitial portion of tube

tion is a safe procedure and apparently prevents further spread of tuberculous in the body. There is no need to do hysterectomy and it is not done unless it makes the operation simpler and safer. We have proved by curettage of the uterus before and after removal of the tubes that the removal of the latter means a cure of tuberculous endometritis. If we are not sure of our diagnosis as to whether the case is tuberculous or not, we

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treat it as non tuberculous and try resection. If trouble ensues later the remaining portion of the tube can be removed.

The cases suitable for salpingostomy. In spite of the paucity of successes after salpingostomy in certain portions of the tube, it is our opinion that the operation should be attempted for all women who want to try the last resource. The tragedy of sterility may be great and even if, as will be shown in results, the percentage of success is small, we must hope that improved technique will bring about improved results and if there are any successes at all the women must be given the chance, however small it may be. Then one can say—"All has been done that is possible if there is no result and you want a baby, adopt one." Alternatively, one can say, "This operation I am about to do has a very small percentage of results, will you have it done or will you adopt a baby?"

Our opinion, that an effort should be made to cure tubal sterility, is shared by many. It is scoffed at by others. Like many techniques, success apparently can be obtained by some practitioners and not by all. The careful choice of cases, the gentle handling of the tubes, meticulous attention to detail, all count. Various techniques have been tried. Splitting of the tubes and gouging out the uterus, as well as other numerous suggestions that have been made, have not been successful in our hands.

Success should be measured not only by the number of pregnancies but also by the patent tubes after salpingostomy.

In considering operations of the tube, we divide our cases into the following varieties:

A (1) Closed at abdominal end of the tube
(a) by adhesions, (b) by some disease in the tube

(2) Tube blocked in some portion of the isthmus (a) by kinks, (b) by disease of the tube

(3) Tube closed in the interstitial portion
(4) A combination of any of these.
(5) Tubes closed by hydrosalpinx

B Too long tubes.

C Too narrow, but patent tubes

As already stated, a very important point in technique is the handling of the tubes. We

have tried various light forceps but the fingers are the best and safest. Hemostats are necessary and we use our curved ring forceps (Fig 6) to control the ovarian vessels.

A *The tube closed at the abdominal end*

(a) by adhesions. This is the simplest case to treat and is attended by best results. The adhesions are separated and the ostium examined. If there is any bleeding surface, a plait of No 4 Luken's catgut is inserted in the lumen to prevent adhesions reforming. At the suggestion of Tweedy the insertion of catgut in the tube during these various operations has been done by us for the last 20 years and numerous varieties of technique have been tried. It is a routine procedure and the tubes have been demonstrated patent in certain cases where it seemed impossible that they could keep open without this measure.

(b) *Disease in the tube.* This is usually a chronic condition following gonorrhea or some postabortive or puerperal infection in the one child sterility case. It is sometimes necessary to remove a portion of the fimbriated end. The following is then done: all bleed and a plait is inserted (Fig 7). Occasionally we have made a definite cuff by rolling back a portion of the tube but a mere oversewing of the tube shows better results on testing.

Tube blocked in some portion of the isthmus. This can be felt and has been shown by salpingography. The following operation is performed (Figs 8, 9). The vessels in the tubal mesentery are tied, the diseased portion is removed without clamping the tubes, a piece of catgut is then passed on a long needle from the fimbriated end through the uterine ostium, the uterus is split, and the catgut knotted in the cavity. There is now a drain the whole way. The endometrial surfaces are approximated the uterus is closed and an end-to-end anastomosis is done on the tube.

If it is certain that the catgut will remain in the tube at the site of anastomosis, it is passed to the uterine ostium and the anastomosis completed without splitting the uterus. Kinks alone in the isthmus can sometimes be loosened digitally or by snips of scissors. It is well in this type of case to have Bonney's sound in position to blow up the tubes while

the abdomen is open to ensure that they are really patent. Alternatively ethidol can be injected from the vagina and can be seen distending the tubes and in the case of open tubes, appearing at the abdominal ostium.

Tube closed in the interstitial portion (Fig 10) The following technique is practiced. All bleeding is controlled the tube is cut away from its insertion into the uterus. If the tube is healthy catgut is passed through it as above described. It is then determined that the uterine ostium is open—a sharp knife is used to shave off uterine muscle until the ostium is definitely exposed. The tube dilators which are really modified lachrymal duct dilators are now brought into action and the uterine ostium is dilated up to the largest size. The anterior wall of the uterus is now split in the midline (Fig 11). The catgut is passed through to the cavity and knotted (Fig 12). The endometrium is approximated by fine catgut sutures and the muscle wall closed by interrupted catgut sutures. The cut surface of the tube is now sutured to the uterine ostium. If the tube is diseased it is removed and the uterine ostium is exposed. It is dilated and a strand of catgut is inserted a new ostium formed and the ovary brought near to this new ostium (Fig 13).

Hydrosalpinx In this a special technique is practiced. The abdominal ostium is opened the fluid milked out the edges oversewed and catgut inserted in the lumen.

B Too long tubes It has been suggested that sterility may follow excessive length of the tubes. In early days, in intractable cases without obvious cause for the sterility a portion of the tube was removed but the results in no way justified the experiment.

C We have noticed what appeared to be great narrowing of the tubes although patent. This is apparently a very real cause and is a matter worthy of investigation. Hormone treatment is worth a trial.

It is not intended to give here the statistics of the many thousands of sterility cases which have come under our notice. Cure is easily obtained in many of them. The cures following ordinary common sense advice, the dramatic cures following the passage of a sound but especially the passage of carbon dioxide

or some opaque substance through the tubes, the cure of backward displacement the very usual occurrence of cure following both small and extensive myomectomies, are common to the practice of all of us. In a paper such as this, one would like to welcome a new comet on the horizon of gynecology one which would diffuse the light of knowledge in regard to the cure of sterility after aspingostomy but that comet, alas, is still in the womb of time. Our cures are few in spite of all efforts, yet they are enough we believe to justify a further trial of the methods of tubal resection.

We have sent a questionnaire to 366 patients who have had tubal resections but many have not replied and rightly and wrongly we have marked them off as failures. There were 28 pregnancies. The operations were as follows:

Eighteen resections at the fimbriated end
Four resections at the isthmus
Six resections in the interstitial portion

In addition there were two tubal pregnancies both after isthmial resection. Of the remaining 336 cases, patency was obtained after tube testing but no pregnancies resulted in 68. Of these:

56 were at the fimbriated end
4 at the isthmus
8 in the interstitial portion.

To sum up the statistics of 366 cases of tubal resection. There were 30 or 8.2 per cent which became pregnant and 98 or 18.5 per cent which either became pregnant or showed tubal patency after operation. Should we then advise our patients to submit to this major operation? Our answer is that the pros and the cons should be explained to the patient, and if she leaves the decision to the surgeon he should operate. Although the cures following tubal resection are not more numerous, I conclude with the hope in my heart that this paper may inspire others to make experiments which will bring about improved technique, followed by success in a large percentage of cases.

Dum spiro spero!

SUMMARY AND CONCLUSIONS

1. The paper is the result of the study of many thousands of cases of sterility

SOLOMONS STERILITY

2 Sterility can be prevented by instruction in puberty and in marriage.

3 Hormone therapy when properly carried out, effects cure.

4 Such operations as splitting of the cervix should be discouraged.

5 In the absence of displacements, tumors, and closed tubes, when the patient is otherwise normal, it is worth while performing laparotomy. Cure of sterility has resulted after separation of peritoneal adhesions.

6 The statistics of cures following such procedures as dilatation of the cervix, insufflation of the tubes, cure of backward displacement, myomectomy, etc., are not given in this paper. Cure in such cases is easy to obtain.

7 The treatment of tubal sterility is discussed. The technique of operation is described. The results of 366 operations are given.

Discussion

DR. LOUIS E. PHANEUF Boston The problem of sterility is such a complex one, that the surgical side of the question is but one part of it. Since Dr. Solomons has limited his remarks to the surgical possibilities as they apply to the female I shall confine my discussion to that particular phase of the subject.

When the rigid intact hymen is a cause of sterility a simple dilatation under anesthesia may be sufficient while in some instances, in the presence of severe vaginismus and dyspareunia, operation becomes necessary to enlarge the vaginal introitus. Tumors of the vulva interfering with normal coitus should naturally be excised.

Theoretically at least, stenosis of the cervix should not play an important rôle in the etiology since it seems logical to feel that if there is sufficient room for the passage of the menstrual discharge, there should be no obstruction to the ascent of the motile spermatozoa. Endocervicitis, however, as a sequence to lacerations and infections, with the resulting plug of mucus enmeshing the spermatozoa, is responsible for sterility in many instances. Like Dr. Solomons, I feel that anterior and posterior incisions of the cervix have no place in the treatment. I prefer the metal dilators to the sea tangle tents if the cervix has to be dilated. Endocervicitis, in my hands, has been treated successfully by coining the hymens electrically with the high frequency current, the Hyams electrode being used. This is an office procedure carried out under local anesthesia. Healing takes place during the course of from 4 to 6 weeks and the infected, hypertrophied endocervical mucosa becomes replaced by squamous stratified epithelium. I have seen pregnancy follow this method in a number of cases.

Retropositions of the uterus, *per se* are not a serious cause of sterility although we all have seen, in the absence of other causes, pregnancy follow their correction. In the congenital type of retroversion, where there exists a short anterior vaginal wall, pulling the cervix toward the symphysis, the anterior wall should be lengthened by operation before shortening the round ligaments. With a mobile uterus remaining in posterior position because of relaxed ligaments I have seen satisfactory results when the

uterine malposition was corrected by means of a well fitting pessary. I would not therefore discard this form of treatment entirely. As a complication of retrodisplacements, we frequently find adhesions of the tubes and ovaries to the broad ligaments even though the tubes may be patent as shown by the Rubin test and the injection of iodized oil. Dr. Solomons has emphasized the necessity of freeing these adhesions before suspending the uterus. I would call attention to cystic ovaries as a cause of sterility and would urge the puncture of these small cysts or even the resection of certain ovaries at the time of the pelvic operation. Occasionally marked lacerations of the pelvic floor may cause sterility by extensive relaxation of the vagina making it impossible for the seminal fluid to remain in contact with the cervix long enough to permit the entrance of the spermatozoa into the uterine cavity. A proper repair of the pelvic floor will obviously correct this defect.

Uterine fibroids are an important cause of sterility. Myomectomy in properly selected cases, has been followed by pregnancy in a high percentage of cases—as high as 33 per cent in some series. The operation, obviously cannot be performed with these results if the tumors have become too large and too numerous, because of the sacrifice of extensive areas of endometrium in their removal. The increased danger of hemorrhage and sepsis following the enucleation of abundant large tumors should also be taken into account.

There is a marked difference of opinion as to the value of salpingostomy, tubal anastomosis, and the implantation of a resected tube in the uterine horn. Dr. Solomons reports 28 pregnancies in 366 women so operated, or 7.6 per cent. His results are as good or better than those obtained in most clinics. I am in full accord with him that in the presence of these figures, the decision for this type of operation should be left to the couple under consideration, but I personally advise against operation if the decision is left to me.

DR. SAMUEL R. MEAKER, Boston I remember hearing the late Dr. William P. Graves say some years ago that the most hopeful cases of sterility

are those in which the wife presents a pelvic lesion that can be corrected by surgery. The work of more recent years has considerably changed this situation. I should say today that the total benefits of surgical treatment are less than the total benefits of the constitutional treatment, endocrine and other of one or both partners. Nevertheless surgery continues to play and always will play an important part in the rebel of human infertility. We are fortunate to have had this opportunity of hearing the subject presented by a man who is recognized as an outstanding authority.

In one minor particular our practice here differs from that recommended by Dr. Solomons. We believe that there is at times distinct value in plastic operations designed to enlarge the os externum. Viscosity of the endocervical mucus, a common and important factor in sterility, is most difficult to correct unless free drainage can be established. Dilatation does not always prove adequate, since the cervical muscle quickly regains its tone, and in many such cases we do a small posterior median incision.

Our experience with salpingostomy is not extensive, for two reasons. First, we have limited our operations to cases of amniotized-end occlusion, feeling that surgery has little or nothing to offer when blockades exist in other portions of the tubes. Second, we have further restricted the number of our operations by doing them only when all factors apart from the wife's tubes are either corrected or shown to be easily correctable. Under these conditions, we have performed nineteen salpingostomies, with insufflation of gas and injection of oil as routine items in the after-care. Ten of these patients have

conceived; one pregnancy was ectopic, and one woman has had two babies, so that the total result of the nineteen operations is eleven pregnancies, producing ten normal living children.

There is another type of surgical procedure to which we attach considerable importance in sterility. I refer to conservative operations on the ovaries, designed to remove mechanical impediments to ovulation, particularly retention cysts. One encounters some difference of opinion as to the value of such operations. It is not impossible for normal ovulation to occur in so-called polycystic ovaries, but the observation of a long series of cases has led us to conclude that retention cysts, by creating an abnormal intra-ovarian pressure, militate against the maturation and rupture of other follicles, and we believe that the careful removal of such structures increases appreciably the likelihood of normal oogenesis.

I am glad that Dr. Solomons opened his paper by emphasizing the importance of constitutional treatment, and by underlining the ever present responsibility of the husband. I am glad also that he has nothing to say in favor of curettage, for we should appreciate that ablation of the endometrium is scarcely calculated to increase the likelihood of conception. In my opinion the curette has seldom if ever cured sterility and has not uncommonly caused it.

The whole subject of involuntary sterility is one of major importance, not only from the medical but also from the social and economic viewpoints, since it profoundly affects not less than 10 per cent of the human race. We are greatly indebted to Dr. Solomons for his most timely presentation.

HYDROCEPHALUS AND SPINA BIFIDA¹

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FROM time immemorial the arrival of a newborn babe with water on the brain or a deformed back has been greeted by the midwife and physician with a hopeless shrug. The mother was told that the fruit of her labor was spoiled beyond redemption. That attitude often persists even today although many of these unfortunates can be salvaged for a normal, useful life.

Hydrocephalus and spina bifida are occasionally associated from the beginning, and all too often hydrocephalus is produced by well meant but improper operation for the repair of spina bifida.

HYDROCEPHALUS

There are two separate fluid systems within the cranial cavity. The cerebrospinal fluid fills one system which extends from ventricles through extracerebral cisternae to the subarachnoid spaces over the surface of the cerebellum and cerebrum where the major portion of the fluid is reabsorbed into the blood stream. This, Cushing has aptly termed the third circulation. The other fluid collection is found in the subdural space where it is separated from the cerebrospinal fluid by the arachnoid membrane.

Recognition of the separateness of these two bodies of fluid is of the utmost practical importance. Subdural fluid normally very small in amount, is a clear yellow color, richer in protein than cerebrospinal fluid but containing similar amounts of crystalloids such as potassium, calcium and sodium salts. Indeed, if the normal cranium be frozen, thin yellow wafers of ice may be removed from this space which contrast grossly with the colorless ice beneath the arachnoid (3).

EXTERNAL HYDROCEPHALUS

The clinical importance of subdural fluid lies in the fact that when it is increased in amount there results an external hydrocephalus which on superficial examination, may be distinguishable from internal hydrocephalus but which differs from it in one important respect: it is easily curable (4).

External hydrocephalus may be a late result of a head injury, in which case the subdural fluid contains blood or blood pigment. In adults this is apt to form a subdural hematoma, while in infants the fluid part of the collection only may be colored yellow. Furthermore, chronic suppuration in the mastoid or one of the adnasal sinuses may react upon the adjacent dura in such a way as to cause exudation to pass from it into the subdural space. In adults this may be the oft unrecognized cause of the headaches associated with such extradural infections, while in infants the presence of subdural fluid is betrayed by a remarkable increase in head size.

The treatment of infantile subdural exudate is repeated fontanelle puncture. This will usually suffice to bring relief and in young children whose sutures are closing it will save the eyesight which tends to suffer early. Diagnosis may be made by careful superficial fontanelle puncture. If in doubt, the injection of a small amount of oxygen into the space gives a typical roentgenogram of subdural gas.

In adults many examples of "pseudotumor" and so called Quincke's serous meningitis are in reality due to subdural exudation. These patients are relieved as though by magic when a subtemporal decompressive craniotomy is carried out for the albuminous fluid seems to be pocketed in this space for long periods with little or no continuing formation.

In passing, it is worthy of note also that epilepsy sometimes develops in adults as a sequel to the formation of exudate secondary to sinus or mastoid infection. And I have found in these cases that subtemporal decompression results in cessation of the seizures.

INTERNAL HYDROCEPHALUS

This is to be defined as an increase in the amount and the pressure of cerebrospinal fluid associated with dilatation of a part or all of the ventricular system. Little is to be gained

by the usual classification of the condition into obstructive and communicating types. Obstructive hydrocephalus only means that the block is between ventricle and spinal theca. In communicating hydrocephalus the block is farther on in the fluid pathway.

In 44 cases studied completely both before and after death by Dr Arthur Elvidge and myself one or more blocks, usually adhesive were found in every case. The difference between them lay in the situation of the block and in its nature. So far as our experience goes there is no such thing as chronic hypersecretive hydrocephalus. The pathological cause does not lie in the choroid plexus.

There is now no valid ground for doubting that cerebrospinal fluid is poured out from the choroid plexuses within the cerebral ventricles. It passes through the aqueduct of Sylvius and fourth ventricle into the subarachnoid cisternæ where it moves forward beneath the brain and outward in the fissures of Sylvius to the subarachnoid spaces over the hemispheres forming the chief absorbing areas.¹

Although absorption is carried out to some extent in the subarachnoid space over the cerebellum and within the spinal canal and also no doubt within the ventricles themselves, the amount of absorption is ordinarily not great enough to accommodate the outflow from the choroid plexus (2).

Nature of block. Among infants, however in the great majority of cases the obstruction is due to closure of the cerebrospinal fluid pathways by inflammatory exudate or to congenital failure of these pathways to open up when the fluid first begins to form.

In a group of 26 cases of infantile hydrocephalus reported by Dr Elvidge and myself the condition was evidently present at birth—and may therefore be called congenital—in 17 cases. It was apparent in 7 cases that it developed after birth. In those which were obviously postnatal, organized inflammatory exudate was usually found in the subarach-

noid space. In at least 5 cases it was apparent that an inflammatory process had begun *in utero* which observation favors the suggestion of Dandy that meningitis may occur before birth. Thus half probably more of the blocks are due to infection before or after birth.

Ventricular dilatation follows certain well defined rules. In children it begins proximally in the lateral ventricles and marches distally toward the block. If the block is in the basal cisternæ the fourth ventricle and the cisterna magna dilate only after this process has been under way for some time in the lateral ventricles, the third ventricle and the aqueduct of Sylvius (5). Eventually the whole ventricular system dilates equally.

Furthermore dilatation and local cerebral destruction are much more rapid beneath less resistant areas of the cranial vault. Thus decompressive removal of bone in either an adult or an infant is worse than futile. It results in rapid destruction of that particular area of the brain which has been decompressed with no permanent change in the intraventricular pressure.

Cerebral compression results gradually in cerebral destruction but the destruction of the brain due to ventricular enlargement has certain peculiarities. Although the volume of the brain tissue is progressively reduced it continues for some time to function normally and essential structures tend to be preserved. The white matter of the hemispheres seems to suffer most while the convoluted grey matter uncoils itself with less destruction. The white matter is made up of long nerve fibers each of which may give off numerous collateral branches. As the sheets of white matter are stretched it seems possible that the collateral branches are torn off. This would allow a continuation of essential function and would explain the large numbers of scattered compound granular corpuscles laden with fat that are found within the white matter of the progressively stretching hemisphere.

Localization of the block is necessary in any case for practical purposes but certain warnings should be sounded. The passage of an injected dye from one point to another may be of help, Dandy's neutral phenolsulphon phthalein or preferably indigocarmine being

In any normal patient ventriculography or cephalography demonstrates all the details of the pathway and over again, and verifies the fact that the foramina of Luschka and Magendie are actual passages, not closed accidents except in the rare case (probably 1 in 100) where an arachnoid web will pass from space to ventricle. Obstruction in the subarachnoid space disappears completely in an hour or two. Indeed, it disappears so rapidly that 30 or 40 cubic centimeters of oxygen—more than the removed fluid—may be injected during cephalography without raising the intracranial fluid pressure. On the other hand it remains in the ventricles for days.

the most satisfactory. But dyes are on the whole very misleading, for small traces may appear on the other side of a complete functional block. Also the rate of absorption of dye from a cavity is not an infallible index of fluid absorption from that cavity since it may escape with some fluid through the needle tract to be absorbed in the superficial tissues.

The use of air, or better oxygen, makes localization of the block easy and indicates the extent of the dilatation but unless the procedure is followed shortly by effective therapy it may result in death because of the further rise in pressure which follows in the first days after ventriculography. Repeated ventricular puncture has the same eventual augmenting effect upon the pressure.

Intracranial pressure is raised initially by obstruction to the third circulation. This rise of pressure has certain important effects upon the intracranial circulation of blood. Arterial blood enters the large arteries at a pressure that we may call 1,300 millimeters of water. It leaves the cranial chamber normally in the dural sinuses at a pressure of 100 millimeters or less. The large veins on the surface of the brain carry blood which must be at a pressure slightly above that figure and a little above the pressure of the cerebrospinal fluid which is normally 150 millimeters.

In internal hydrocephalus the intracranial pressure varies between 300 and 500 millimeters of water. The pressure within the large cerebral veins must rise correspondingly or the thin walls of these vessels would be obliterated. Chronic hydrocephalus does not cause the systemic arterial pressure to rise, but the blood stream within the arterioles and venules of the choroid plexus must be under a much increased pressure in order to maintain a flow outward to the sinuses through the great vein of Galen for example. This vein would of necessity collapse unless its intramural pressure equaled that of the cerebrospinal fluid.

It seems probable that this increased arterial pressure within the choroid plexus and the enlargement of local capillaries which must accompany it within the choroid plexus, must produce an increased outpouring of cerebrospinal fluid even against the raised pressure

of that fluid medium. Thus the original interference with absorption may well result in a "vicious circle" of further increase in fluid production—until fluid formation is balanced by arrival at a pressure against which little or no fluid can pass out through the cell walls of the choroid.

That the venous pressure within the intracranial sinuses is greatly augmented in internal hydrocephalus is shown by the appearance of an increased number of dilated veins which appear typically in the scalp of a hydrocephalic infant. These scalp veins are fed by perforating communicators. The cyanotic appearance of the scalp itself in these patients bears the same testimony. On the surface of the dilating ventricle and in the cortical pia as well, vessels increase in number and complexity until the time when the hemisphere wall is reduced to a membrane when the vessels disappear altogether.

Therapy. Certain lines of attack are self evident. First of all the cause of obstruction may be removed surgically in the case of a tumor. In adults it may be removed surgically also in certain cases of adhesive arachnitis, usually involving the leptomeninges of the posterior fossa. This adhesive condition seems to be inflammatory. In a number of my own cases there has been a history of a previous illness resembling influenza. Clinically the cases usually suggest a pre-operative diagnosis of cerebellar tumor. Separation of a few meager adhesions results in surprisingly satisfactory relief. It is unnecessary to say that appropriate medication may remove even a complete block in a syphilitic lesion.

Intelligent therapy calls for localization of the site of the block. Forty four of our cases of internal hydrocephalus, which will be reviewed by Dr. Elvidge, were as follows. In 21 cases the block was found to be in the subarachnoid space. In 14 cases the first block was in the aqueduct. In 3 the obstruction was in the third ventricle, in 1 it was of the foramina of Magendie and Luschka, and 3 cases presented extensive hydromyelia difficult to classify.

Removal of the block is obviously impossible in the average infantile hydrocephalus. The first block may not be the last. If an aqueduct is closed the subarachnoid space may be closed

also and it is probably impossible to open it. Thus explains the failure even in the hands of the most expert surgeons, of heroic attempts to carve out new pathways. A true obstruction of the foramina of Luschka and Magendie should be removed surgically but this is a very rare condition in our experience (1 case in 44). Simple dissection of the posterior foramen which is so effective in adult adhesive arachnitis does not suffice in infants.

Short-circuiting of the cerebrospinal circulation is occasionally effective this means making an opening from some ventricular space directly through into the subarachnoid spaces. Corpus callosum puncture has in a few rare instances on record resulted in cure. Subtemporal and subfrontal exposure of the basal cisternæ and incision through them into the third ventricle has been carried out by Dandy and by Naffziger. This may well prove to be the best site for short-circuiting.

Removal of choroid plexus has long been carried out by occasional optimistic surgeons, and all surgeons who continue to face the hydrocephalus problem require the support of forthright optimism. The choroid plexus is not the seat of the pathological cause and for that reason the procedure of removing it has been likened to the removal of the kidneys for stricture of the urethra. Nevertheless there are not a few cases in which some capacity for fluid absorption is preserved. The procedure in such cases seems rational. The best method is no doubt the cautery devised by Dr Tracy Putnam which has reduced the operative shock to a minimum.

Postural dehydration is a method of treatment invaluable for mild cases. Those cases of infantile hydrocephalus in which there is a close balance of absorptive capacity and fluid formation, gradually develop a greater absorptive capacity if they can be carried on over the first year and the balance is tipped in favor of absorption by this method.

The child should be kept continuously with the head above the sacrum. The head of the crib should be kept up as high as possible and the patient should be carried in a perpendicular position always. This reduces the pressure in the emerging cranial veins to a minimum, thus promoting absorption and decreasing

intracranial pressure. Further the diet should be concentrated as much as possible. Even small infants should be placed on a high percentage of solid food such as gruels with no water added. Success demands careful pediatric help and supervision. The concentrated diet usually makes the infant constipated.

For 10 years I have used this treatment for less severe cases of hydrocephalus and I have seen many (perhaps 10 or 12) permanent cures, particularly in cases associated with spina bifida. Fay has found dehydration helpful in this condition as in numerous others.

In conclusion the treatment of hydrocephalus demands separation of the cases of external fluid collection from internal hydrocephalus. In internal hydrocephalus there must be a careful analysis of the nature and site of the block. If the block is not removable by medical or surgical means 'short-circuiting' procedures provide a hope of success in those few cases in which the subarachnoid space remains open. Removal of the choroid plexus by simpler procedures may also have a future. But for milder cases, and as an added help to other methods of attack, *postural dehydration* will be found to be of great value.

Confession is good for the professional soul. I must therefore confess that after the cases of removable block are eliminated, after external hydrocephalus is eliminated and after the mild cases of internal hydrocephalus are set aside, I face the remaining hydrocephalic infants with an uncomfortable premonition of failure a premonition which I am sure is not shared by those surgeons chosen to discuss this paper. Dr. Mixer and Dr. Putnam.

SPINA BIFIDA

In regard to spina bifida, well directed therapy may be much more effective. Three years ago my associate, Dr. William Cone, and I presented a study of 33 cases of spina bifida and cranium bifidum and we described an operative procedure which adequately closes the defect and at the same time preserves the meningeocele sac, thus avoiding the danger of hydrocephalus as a sequel to operation (6).

Subsequent experience has amply justified our hopes for the procedure. In spina bifida there is a defect in the vertebral arches usually

posterior, occasionally anterior. In cranium bifidum the same is true. If the defect is covered with skin the spina bifida is called occulta. If in place of skin, a meningeal sac presents without nervous tissue in it, the spina bifida is said to be associated with meningocele. If the sac contains roots or attached spinal cord, the spina bifida is said to be associated with myelomeningocele. If no sac is formed at all and maldeveloped nervous tissue presents itself, the condition is termed rachischisis or vertebral splitting. Cases of rachischisis are not to be operated upon.

Spina bifida occulta calls for operation only when associated with advancing paralysis during the growth period. Up to the third month of intra uterine life spinal cord and spinal canal are equal in length. From then on the canal lengthens more rapidly than does the cord. As the brain cannot be displaced from its proper cavity the cord migrates upward or to be more accurate the canal grows downward away from the cord while the spinal roots elongate and the cord itself terminates at the first lumbar spine instead of the last sacral. In all forms of spina bifida the cord or roots are apt to be attached locally to the protrusion. Hence at any time during growth of the patient's body spinal symptoms may develop due to an increasing downward traction. This most often manifests itself as progressive incontinence of urine, or progressively increasing weakness in the feet. The only treatment is of course operation to free an attached cord or spinal roots.

Spina bifida with meningocele or myelomeningocele presents a sac—an evaginated diaphragm. This sac is ballooned out over the defect by cerebrospinal fluid. The sac tissue is made up of gelatinoid material which weeps spinal fluid on section. Histologically fluid spaces are seen within it. Blood sinuses and arachnoidal cell tufts are encountered, identical in structure and arrangement to the pachionian bodies and dural sinuses of the cranial cavity. Consequently the tissue of the sac resembles the absorbing tissue of the cerebral arachnoid. This sac is an absorbing mechanism for spinal fluid as we have shown by injection of intravital dyes during life. Further proof that this is the case, is the well

known fact that hydrocephalus may be produced by surgical amputation of this sac.

Dorothy Russell has recently pointed out that spina bifida with meningocele is associated with an elongation of the bulb and cerebellum downward into the cervical canal so that the cervical roots run in a cephalad direction to their foramina of exit. She urges that this abnormality—the Arnold Chiari malformation—allows the spinal fluid to pass from the fourth ventricle downward into the spinal canal, but blocks its passage forward into the basilar cisternæ so that the meningocele sac replaces the cerebral subarachnoid spaces so far as absorption of fluid is concerned.

PLASTIC REPAIR

From this demonstration it follows at once that the proper surgical procedure for treatment of spina bifida should include preservation of this fluid absorbing tissue, which may take the form of a sac or of a sponge.

The protrusion is covered by a continuation of the skin which may be no thicker than a membrane, a circular incision should be made so as to preserve as much good skin as possible for closure. The skin and membrane which cap the protrusion are then peeled off by careful sharp dissection. The sac is opened evacuated of fluid, sutured again and rolled up in a little heap and covered by a protective layer of fascia. The fascia for this closure can usually be obtained by reflecting the covering of the muscles of the back toward the spinal defect, leaving the attachments of the fascial flaps at the margin of the defect.

The skin is then drawn together, great care being taken to put all strain upon a suture layer in the superficial fascia and not on the skin itself. The danger of infection and of hematoma formation in the dead space beneath the skin is an ever present one. Careful handling of tissue, closure with fine interrupted silk sutures, application of waterproof protective dressing, and immobilization of the infant in a prone position are among the procedures which contribute to successful healing.

What has been said above in regard to spina bifida applies equally to cranium bifidum. The defect is usually in the suboccipital region with maldevelopment of the cerebellum be

neath the defect, yet the children seem to grow up quite well except for an ataxic gait.

Well over half of the total cases of spina bifida and cranium bifidum are suitable subjects for operation with a mortality no greater than 10 per cent. Contra indications to operation are gross paralysis, pre-existent hydrocephalus, or the absence of sac, as in rachis chisis. An ulcerated or ruptured sac should be operated upon within 24 hours of birth, if possible. Otherwise 3 to 4 weeks of age is the time of election.

After operation the tendency to hydrocephalus which many of these infants will show must be combated by postural treatment and by energetic dehydration. This aids cerebrospinal fluid absorption as it does in any case of mild hydrocephalus, but further erect posture raises the pressure of cerebrospinal fluid at the level of the meningocele sac thus increasing the rate of absorption in that organ.

Such an article as this could hardly do justice to pathological anatomy. But practical therapeutics must be the primary interest of all surgeons worthy of the name. Many

infants with spina bifida are being allowed to die each year—infants who might have grown up to be normal men and women if the available surgeon had understood the principles involved in treatment. And nothing in surgery is so satisfying as the knowledge that one has saved a life when others had abandoned hope for the poor derelict.

BIBLIOGRAPHY

- COSGROVE, H. The third circulation and its channels. Studies in Intracranial Physiology and Surgery. Oxford University Press, 1926.
1. DAVY, W. and BLACKMAN, K. Internal hydrocephalus. *Am. J. Dis. Child.* 1914, 8, 406.
2. PENFIELD, W. The cranial subdural space: a method of study. *Anat. Rec.*, 1915, 23, No. 2.
3. Idem. Subdural effusion and internal hydrocephalus. *Am. J. Dis. Child.* 1923, 26, 383.
4. PENFIELD, W. and ELVIDGE, A. Hydrocephalus and the atrophy of cerebral compression. Chapter 23, Cytology and Cellular Pathology of the Nervous System. New York, P. B. Hoeber Inc., 1932.
5. PENFIELD, W. and COVEY, W. Spina bifida and cranium bifidum: results of plastic repair by a new method. *J. Am. M. Ass.*, 1932, 98, 454.
6. RUSSELL, D. Mechanical factors producing hydrocephalus in spina bifida. Read before McGill Chapter of Alpha Omega Alpha, September 26, 1934. In press.

Discussion

DR. WILLIAM J. MIXTER, Boston. Dr. Penfield has stated that confession is good for the soul that notwithstanding his investigations he faces many cases of hydrocephalus with a premonition of failure but thinks Dr. Putnam and I should not do so. I don't see why he says that I should have less of this feeling than he. In the earlier days of neurosurgery our results were far less favorable than at present and hydrocephalus has always been a neurosurgical bugbear.

I agree that the usual classification of communicating and noncommunicating hydrocephalus is of little value. It is important, however for us to know the position of the most distal block. If it be in the aqueduct or the roof of the fourth ventricle a determined attempt to remove the block or form a false passage is in order. Some of our most spectacular cases are in this group but unfortunately the group is small. The use of dyes and ventriculography, as Dr. Penfield has stated, is uncertain and sometimes dangerous, yet these measures do help us somewhat, particularly the latter. What we really need is a test that will conclusively demonstrate block between the basal cisternae and the cerebral subarachnoid space or a fault in the absorptive mechanisms. If the block is in either of these locations (and it frequently is) all operative procedures directed toward removal of block from the aqueduct or fourth ventricle or attempts to form a new stoma

between the third ventricle and the interpeduncular cistern will be doomed to failure. Several years ago I attempted this procedure with the use of a cystoscope and though I could puncture the floor of the third ventricle the operation was not a success.

I feel as Dr. Penfield does that exposure of the basal cisternae and incision of the third ventricle is hazardous and unsatisfactory. Nevertheless, a short-circuiting operation of this sort may be considered in selected cases when the time comes that we can definitely locate the position of the block.

I have felt that operative removal of the choroid plexus was too hazardous an operation to be of great value, but I have watched Dr. Putnam develop his technique with great interest and believe that it is by far the most satisfactory, particularly where some portion of the absorptive mechanism is still active.

Dr. Penfield has described postural dehydration and restriction of fluid intake. These I believe to be of great importance in the mild case and a useful adjunct to operative interference in the severe one.

In his discussion of spina bifida Dr. Penfield states that spina bifida occulta should be operated on only during the period of growth and if neurological signs are increasing. I should be a little more enthusiastic than that. Certain cases of spina bifida occulta have associated congenital neoplasms of the cauda equina which are removable and can be demonstrated only by operation, while others will show an increase in

neurological signs due to traction after the period of growth has ceased. Therefore, in the face of a definite percentage of unsuccessful operative procedures I should advise careful investigation of many of these cases with operative interference in mind.

Dr Penfield's idea of preservation of the sac in the treatment of spina bifida with meningocele or myelomeningocele is a distinct step forward in the treatment of this distressing condition and should materially reduce the incidence of postoperative hydrocephalus. I agree with Dr Penfield that if rupture of the sac is present at birth immediate operation is indicated, and from my own experience I would go farther and say that impending rupture is an indication for immediate operation. These tiny infants, during the first 3 days of life, are better subjects for surgical intervention than they are at 3 weeks. I am opposed to any surgical interference in patients in whom the local or neurological signs indicate irreparable and complete damage to the nerve roots supplying bladder rectum, and legs, even if repair of the skin defect seems possible.

DR. TRACY J. PUTNAM, Boston I am pleased that Dr Penfield emphasized the fact that cortical atrophy occurs relatively slowly as a result of increased pressure alone—perhaps no more rapidly than in adults with increased intracranial pressure. It is my impression also from both clinical experience and autopsies, that many of the infants who remain imbeciles following relief from hydrocephalus were those who suffered in the first place from a primary cortical aplasia.

I shall confine my discussion largely to the subject of hydrocephalus since it is in respect to this condition that we have experienced the new awakening of hope to which Dr Penfield has referred. Our experience with congenital hydrocephalus has been briefer than his, but I should judge happier. Perhaps I may best define my own experiences with endoscopic coagulation of the choroid by giving some brief statistics. The operation has been performed 38 times in 16 patients. In all of these patients the intracranial pressure has been decreased. Seven of them are alive and have shown no enlargement of the head or bulging of the fontanelle for periods of weeks to months. Of these patients 1 developed a diplegia apparently the result of its fourth operation. An eighth child is alive, and its intracranial pressure has been somewhat relieved but further operations are not planned on account of the patient's general condition.

Turning to the other side of the ledger there are 8 deaths to report. Autopsy has been performed in 3 of these. The reported causes of death have been infected meningocele, with microgyria bronchopneumonia microgyria and absence of the corpus callosum bronchopneumonia with microgyria. Of

the 5 other cases, only 1 was from postoperative hyperthermia, indeed this was the only case in which death occurred within 48 hours after operation. Two patients died of respiratory infection 1 of diarrhoea, 2 patients died at home after discharge from the hospital.

Though laying myself open to the charge of optimism, I cannot help feeling that these statistics could easily be much improved. Up to the present, our policy has been to operate upon every case no matter how desperate in order to see how much could be accomplished and what the dangers of secondary damage might be. Some of the patients have been almost moribund at time of operation, others have been almost certainly doomed, as for example, the child with the leaking meningocele. We now know a little better what can be accomplished and our necropsies have shown that damage to brain tissue is slight. While it appears quite unjustifiable to pay too great attention to one's operative statistics in a disease which carries such a high mortality as hydrocephalus we are now beginning to refuse the hopeless risks. Doubtless as a result, I have had only 1 death among the last 6 patients operated upon.

It seems to me not wholly appropriate to compare the choroid to the kidney. I doubt whether any series of bilateral nephrectomies would show a mortality as low as 50 per cent even if a few stray bits of tissue were left behind. Perhaps an apter analogy would be removal of the gall bladder for obstruction of the cystic duct.

I have sometimes considered in regard to certain of the cases reported here, whether I should not do encephalograms, or without them explore the posterior fossa and catheterize the aqueduct or loosen adhesions. I have never brought myself to do either feeling that ventriculocopy alone is a more conservative procedure. The situation would, of course, be different in a child in whom the possibility of tumor or arachnoiditis had to be considered.

While my own experience with spina bifida is small, I should like to comment briefly on Dr Penfield's remarks on this subject also. I think we can all agree that the best results are to be obtained in cases in which it is possible to do a closure in layers as he recommends. I personally should not feel justified in restricting myself to such cases, for while the mortality of operations on scissile sacs and on patients with paralysis is high occasional good results are obtained as a small reward for much labor expended. Further we are less disturbed by the possibility of development of hydrocephalus than formerly.

The subject of the surgery of hydrocephalus is by no means closed, and all of us who are faced with the problem are looking forward to hearing Dr Penfield's full report of his survey of the splendid collection of pathological material in his possession.

THE DIAGNOSIS AND TREATMENT OF DIVERTICULITIS AND DIVERTICULOSIS¹

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DIVERTICULA are noted at all points in the intestinal tract from the pharyngo-oesophageal junction to and including the rectum. While accurate anatomical descriptions chiefly from postmortem studies were given by various authors—notably Virchow, Graser and Fischer—during the latter part of the last century the appreciation of their surgical significance came with the beginning of the present century the attention of the profession being directed to it by the papers of Beer, W. J. Mayo, Moynihan, Drummond, Mummery and others.

In the last 25 years the literature upon the subject has become quite voluminous based upon clinical and pathological studies of a sufficiently large number of cases to warrant accurate interpretation of pathology, diagnosis and treatment. The fact that in their symptomatology they offer a counterpart of other diseases common to the intestinal tract at the points at which they occur lends an added interest to their study. They occur as sacculations projecting from varying portions of the circumference of the intestinal tube—mesenteric, antemesenteric and lateral. They may range in number from one to several hundred. Hausman reports one instance in which 400 were found. They are usually single in the oesophagus, single or comparatively few in the duodenum and jejunum chiefly of the Meckel's type in the ileum and they reach their greatest profusion in the colon particularly in its left half. Diverticula have been described as congenital or true and acquired or false; the former containing all the coats of the intestinal tube the latter representing protrusions or herniations of the mucous and submucous coats through apertures in the muscularis. The term diverticulosis connotes the presence of such sacculations while diverticulitis implies the varying changes which occur as the result of irritation and inflammation. Pulsion diverticula of the pharyngo-oesophageal junction are observed usually at

the level of the lower border of the cricoid cartilage. They occur most frequently in men and commonly as one approaches or passes middle age representing a protrusion of the mucous membrane between the muscle fibers forming the posterior wall of the pharynx. The longitudinal muscle fibers diverge at this point to their insertion in the cricoid cartilage the gap created by this divergence is filled in with the transverse and oblique fibers of the inferior constrictor forming a thin muscular coat weaker than the remaining portion of the pharyngo-oesophageal tube. As a result of pressure from within, separation of the muscle fibers occurs coincident with a protrusion of the mucosal coat. Always small in the beginning they may attain almost incredible size; one in our series showed a capacity of one pint and extended into the chest as low as the third rib. The entrance to the sac is always on the posterior wall but the sac itself as it develops pursues a downward course along the oesophagus, far more frequently on the left than on the right side; exceptionally long ones reaching at times well into the thorax.

During the early stage of development the symptoms are obscure. The decomposition of retained food particles gives rise to irritation in the sac and at times in the larynx, causing cough and the expectoration of a tenacious mucus. Difficulty in swallowing is occasioned by the filling of the sac, the food being regurgitated into the mouth either because it cannot pass the distended sac or else because muscular contraction forces up the food which has lodged in it. Not infrequently the patient repeatedly empties the distended sac by pressure with the hand the process of getting down a satisfying quantity of food being a protracted one. Sooner or later the nutrition suffers and there is both loss of weight and strength, with more or less marked dehydration. With fairly large sacs which have not yet found their way into the thorax a visible swelling appears in the neck when they be-

come filled with food. In addition to the dysphagia large sacs may occasion hoarseness by pressure on the recurrent laryngeal nerve and dyspnoea by pressure on the trachea. The development of the sac is essentially a slow one. The history of increasing difficulty of swallowing over a long period of time, with the regurgitation of food showing no evidence of gastric digestion, strongly suggests the presence of diverticulum. The additional presence of a swelling in the neck following attempts at swallowing food makes the diagnosis fairly certain. Fluoroscopic examination, employing both anteroposterior and lateral views during which the patient attempts to swallow a barium acacia meal, will give full information as to the location, size, and shape of sac.

Curative treatment consists in extirpation. In patients debilitated by starvation and dehydration it is essential that adequate preparatory treatment be carried out before operation is undertaken. This consists in the administration of food and fluids by means of the Levine tube or catheter if either can be passed beyond the mouth of the sac, otherwise of glucose and fluids introduced intravenously and subcutaneously. In an extreme case in which there had been a weight loss of more than 100 pounds and in which all efforts to enter the oesophagus, including direct vision with the oesophagoscope, had failed, we resorted to gastrostomy as a means of giving nourishment over a sufficiently long period to enhance the safety of extirpation. When the sac has reached the thorax we prefer the two stage operation advocated by C. H. Mayo, by which procedure infectious mediastinitis can usually be avoided. The one stage operation is satisfactory for the smaller sacs. Various methods of dealing with the neck of the sac have been suggested. We have endeavored to close them with suture placing a wick of rubber tissue down to the site of closure to take care of leakage should it occur. Postoperative feeding for the first 4 days is given through a tube introduced through the nose or mouth to a point below the site of operation, after which time fluids and semi-liquid foods are given until the wound heals. Deep-seated diverticula of the oesophagus are much rarer than those at the upper end, are usually of the

traction type, and rarely occasion symptoms unless associated with cardiospasm. In the latter event dilatation of the cardia will usually bring about relief of symptoms.

Diverticulosis of the small intestine, first described by Chomel in 1710, has, with the exception of Meckel's diverticulum, received no surgical consideration until within the present century, most of the records having appeared in the past decade. Diverticula are not infrequent in the duodenum, being found in all 3 of its divisions. They are less frequently observed in the upper portion of the jejunum and with the exception of the diverticulum of Meckel are seen but rarely in the ileum. In the majority of the reported cases the opening into the sac has been situated on the mesenteric side while both lateral and antemesenteric openings have been described. Both the congenital, or true, and the acquired, or false, types are found in the small intestine and are observed at all ages, the latter being most frequent at and after middle age. The former have been found in infants at birth and are usually single, they have been found with pancreatic tissue at their apices, while their most frequent location in the duodenum is near the papilla of Vater, where the pancreatic ducts are developed from duodenal buds. The acquired ones develop and produce symptoms late in life when atrophy of the muscularis, particularly the circular coat, may be a predisposing factor, they occur most frequently on the mesenteric side of the bowel where the vessels penetrate the muscularis. They vary in depth from $\frac{1}{8}$ inch to 2 inches or more. The fluidity of the contents of the small intestine is such that solid material is rarely found within these sacs although the stomata which connect the diverticula with the intestine are smaller than the cavities of the diverticula.

Chomel in 1710, Harley in 1875, and Cole and Roberts in 1920 have reported diverticula of the duodenum containing gall stones while Terry and Mugler and C. M. Watson report instances of intestinal obstruction due to the formation of enteroliths in diverticula of the jejunum. Morrison and Feldman report a primary carcinoma in a duodenal diverticulum.

Diverticulosis of the small intestine may exist throughout life without giving rise to

symptoms, being found only at autopsy. With the retention of decomposing food leading to distention, irritation and inflammation of the sac or its surrounding structures, symptoms arise. None of these are pathognomonic and a diagnosis cannot be made on clinical evidence alone. Diverticula are not infrequently associated with ulcer, cholecystitis and pancreatitis and when so the symptoms caused by the latter will predominate or else bedcloud the picture. Upper abdominal discomfort varying from a slight ache to severe colicky pain is one of the commonest symptoms. The pain may be relieved by food or alkali or may recur after eating and there are frequently long periods of freedom. Sour stomach, belching and nausea are at times noted. The symptoms are so indefinite and so variable simulating those of lesions of adjacent organs that clinical deduction alone will not permit a diagnosis. The condition may however be demonstrated with a high degree of accuracy with the X ray. The information which such an examination affords gives one an important lead in evaluating the significance of the presence of diverticula. Those which are discovered accidentally during routine X ray examination of the gastro-intestinal tract and which are not causing symptoms require no treatment. Those in which inflammatory changes are present may require excision. The observation of retention of barium in a diverticulum for a much longer time than is required for the emptying of the stomach associated with tenderness on point pressure, when other upper abdominal lesions are ruled out may be considered as indicating diverticulitis. In the event of associated ulcer, cholecystitis, or pancreatitis, it becomes a matter of judgment to appraise correctly the rôle played by each and to determine for or against excision of the diverticulum in addition to selecting the appropriate treatment of the associated lesion. In case of doubt or in debilitated patients in whom the excision would materially enhance the operative risk, the latter procedure may be omitted until such time as the indication for it becomes more apparent.

For patients in whom the employment of surgery is contra-indicated and for those in whom symptoms are not sufficiently definite

to warrant operation a medical treatment based on that for duodenal ulcer is most likely to give good results. When the roentgenological examination has shown the presence of spasm of the pylorus or duodenum the additional employment of belladonna will be helpful. Constipation which is a frequent accompaniment, should be relieved by appropriate measures.

The complications of diverticulums of the small intestine which demand surgery for relief are diverticulitis, suppurative peridiverticulitis, perforation and intestinal obstruction. The important anatomical points to be borne in mind are the relation of the peritoneum to the sac, the relation of the sac to the vascular supply of the intestine and the relation of the sac to adjacent structures. The latter point is particularly applicable to duodenal diverticula which may be in close relation to the common duct in front of the pancreas, behind the pancreas or buried in its head. The surgical procedure employed must be suited to the pathological condition found: invagination or excision of the sac with closure of the defect in the intestinal wall, fortifying the latter where possible with an omental fat graft, drainage of abscesses with or without excision of sac, resection of intestine or pylorus, gastro-enterostomy—all find a place in dealing with the various pathological pictures presented.

The most commonly observed diverticulum of the ileum is the persistent intra abdominal portion of the vitelline duct. This type was first accurately described by Johann Friedrich Meckel and given his name in 1812. The vitelline or omphalomesenteric duct connects the yolk sac with the midgut and normally becomes obliterated in the seventh or eighth week of fetal life, the atrophy beginning at the distal end and progressing until the lumen of the ileum is reached. The artery and veins which accompany this duct normally disappear entirely with the exception of that portion which becomes the superior mesenteric artery and vein. Complete failure or obliteration will leave a tube communicating with the ileum at one end and with the umbilicus at the other from the latter of which feces are discharged. Obliteration at both ends will

leave a tube connected by a fibrous cord either to the umbilicus or the ileum or to both. Such a remnant may give rise to tumors of various types, cysts, carcinoma, sarcoma, and malignant myoma having been reported. Obliteration at the distal end leaves a tube of varying length connected with the ileum and communicating with its cavity. It may be found at any point of the small intestine below the duodenum the usual location being from 10 to 30 inches above the ileocecal opening. Its usual attachment is antemesenteric and its length varies from a small protrusion to one (reported by Moll) 33½ inches long. Its distal end may be free or be attached by a fibrous band to the umbilicus, mesentery or adjacent organ. In shape it may be spherical, conical, bulbous, or somewhat like the finger of a glove. Its walls consist of the normal coats of the ileum, possessing at times Lieberkühn's follicles, Peyer's patches, gastric mucosa, and even accessory pancreatic tissue. Its incidence as estimated from autopsy statistics varies from 1 to 2 per cent. Surgical records have shown a varying incidence, as a rule somewhat lower than that derived from postmortem studies. This interesting vestigial remnant is responsible for a number of acute abdominal conditions which carry a potentially high mortality. It is a prolific cause of intestinal obstruction as a result of its attachment to the umbilicus or to some other portion of the parietal peritoneum, mesentery or intestine resulting in constriction by band or kinking from traction. Volvulus of the diverticulum itself has been reported as well as volvulus of the loop of ileum from which it springs. Obstruction may be produced by an intussusception, the intussusceptum having for its apex the invaginated diverticulum or the point of the ileum from which it arises. Hertzler and Gibson in 1913 reported such a case together with a careful study of 41 similar instances recorded in the literature. The average age was 13 years with 49 per cent under 10 years of age. Of the 22 resections in the series 13 died and 9 recovered, a mortality of nearly 60 per cent. Further reports are available in the literature, only recently we have observed this complication in a boy of 6 years, admitted to the hospital moribund with a

palpable mass in the right lower quadrant. A diagnosis of intestinal obstruction due to intussusception was made from the history and physical findings. Autopsy showed an invaginated diverticulum with the ileum telescoped into the ascending colon.

Inflammation of Meckel's diverticulum simulates very closely that observed in the appendix, both as regards the symptoms and the sequence of pathological events dependent upon it, for it causes diverticulitis, peridiverticulitis, abscess and perforative peritonitis. The symptoms of obstruction produced by the various lesions of Meckel's diverticulum, as well as those of the inflammatory phenomena induced by it, do not in any wise differ from those arising from other causes. The history of a persistent umbilical fistula or the finding of an ileocolic intussusception in a subject beyond the age of infancy are suggestive, so also are right-sided appendiceal symptoms in the known absence of the appendix. X-ray studies have been of little value in the recognition of Meckel's diverticulum. No one symptom or combination of symptoms, aside from the presence of a congenital umbilical fistula, can lead to any high percentage of correct diagnoses.

The important lessons to be learned from the literature on Meckel's diverticulum are that its complications possess an inherently high mortality and that prompt diagnosis, at least of an abdominal emergency, with consequent early operation is important. The procedures employed must needs suit the individual case and consist in enterostomy, release of obstructive bands and intussusception, ablation of diverticulum, resection of intestine and drainage, as indicated by the pathological findings. In view of the possible dangers from a Meckel's diverticulum, it should be removed when encountered in the course of operations for other lesions. My associate and I have seen symptomless diverticula in 31 instances, 30 in the abdomen and 1 in the sac of an inguinal hernia. Twenty nine were removed, the 2 remaining possessed such wide openings and shallow depths as to render improbable the occurrence of complications. Schaetz (25) in 1923 pointed out that islands of gastric mucosa occur in the vitelline duct and proposed the theory of

embryonal transplantation. Later he studied 30 specimens of Meckel's diverticulum by serial section. Of these only 17 or 57 per cent, were free of abdominal elements. Three or 10 per cent showed mucosa belonging to higher segments of the small gut jejunum and duodenum. Five or 16.6 per cent presented islands of gastric mucosa, one contained pancreatic tissue and one pancreatic tissue and gastric mucosa. Muelengracht in 1918 Magend and Durant in 1922 Clubal and Hallopeau and Humbert in 1924 reported instances of peptic ulcer in Meckel's diverticulum showing both hemorrhage and perforation.

Ashner and Karelitz in 1930 collected and studied 33 reported cases of peptic ulcer in Meckel's diverticulum and the ileum. The most common symptom was the passage of fresh blood and clots per rectum; it was absent in but 5 of the 33 cases, and in 1 of these anemia was noted. The periods of bleeding varied from 1 of 36 hours causing death in an infant, to a man of 28 who had repeated hemorrhages since childhood. Pain of some sort was noted in 21 cases; in many its onset being coincident with perforation. Sudden perforation was noted in 11, one third of the total number. A palpable mass was observed in 3, thus with the passage of blood suggested intussusception, but the stools lacked the usual admixture of mucus and the symptoms of obstruction were wanting. Gastro-intestinal X-ray studies were made in 6 cases without giving helpful information. They suggest that unexplained cases of repeated intestinal hemorrhages in which other lesions have been excluded be subjected to exploratory laparotomy. If peptic ulcer or Meckel's diverticulum be found, the operation of choice is excision of the diverticulum with enterorrhaphy at right angles to the long axis of the intestine. Their summary is as follows: Heterotopic gastric mucosa has been shown to occur at the umbilicus as a result of anomalous developmental structures arising from the omphalomesenteric duct. Such areas of mucosa have been demonstrated to produce a secretion containing free hydrochloric acid and pepsin with irritation, erosion and ulceration of the surrounding skin. The secretion could be excited by the ingestion of food or by local mechanical stimuli. Hetero-

topic gastric mucosa has also been demonstrated in Meckel's diverticula which have retained their connection with the lumen of the ileum. Chronic ulcers causing pain, hemorrhage and perforation, and histologically identical with peptic ulcer of the stomach, duodenum and jejunum have been described in Meckel's diverticulum and the ileum in 33 cases. In 21 of these gastric mucosa was demonstrated in the diverticulum. The ulcers occurred in the intestinal type of mucosa, adjoining the heterotopic gastric mucosa, being frequently located at the neck of the diverticulum which was usually completely lined by gastric mucosa.

The occurrence of diverticulosis is observed far more frequently in the colon than elsewhere in the intestinal tract. Autopsy records would indicate its frequency in 5 per cent of all subjects over 40 years of age. While the vast majority occur at and after middle life they have been reported at much earlier ages. A. P. C. Ashhurst reporting a sigmoid diverticulitis in a child of 7 years and 9 months and Erdmann one in a child under 7 years of age. Only 20 in 1,819 patients at the Mayo Clinic showing diverticulosis of the colon were under 40 years of age. Diverticula of the sigmoid are by far the most common; the descending colon also being frequently involved. It is estimated that on an average 85 per cent are found in these two portions of the colon. The rectum, transverse and ascending colon share in the distribution of the remaining 15 per cent, with infrequent similar findings in the appendix. Our series shows 6 patients presenting diverticulosis of the appendix. In one of whom a diverticulitis with perforation had occurred. Stout (28) reports an incidence of 1.89 per cent, of diverticulosis of the appendix in the cases of appendicitis operated on at the Presbyterian Hospital, New York, in 1 year. The diverticula occur between the layers of the mesoappendix, projecting from the appendix like buds and are frequently multiple. In addition to the danger of diverticulitis and perforation, the simple ones afford an added risk since in the process of cutting through the mesoappendix close to the appendix they may be opened with resultant contamination of the operative field. While diverticula of the

colon may be single, they are as a rule multiple, varying in number within rather wide limits. Practically all of those observed in the colon are of the false or acquired type, the sac consisting of mucosa and submucosa covered with peritoneum. Regardless of the cause—upon which there is no unanimity of opinion—once the diverticulum is formed it becomes a bottle-shaped process, with a narrow mouth and wide body, into which the faecal current enters with the eventual formation of faecaliths. There is consequent inflammatory change secondary to the obstruction and stagnation. There are no symptoms referable to simple diverticulosis. The percentage of such cases that ultimately develop diverticulitis and present subjective symptoms is conjectural, but has been estimated at from 10 to 20 per cent. The symptoms are caused by inflammatory changes in the sac and surrounding structures, notably in the mesentery, dependent upon inadequate drainage of the sac. The faecal current in the right half of the colon is largely liquid while that in the left half tends to become more and more solid, with the result that diverticula in the left half more frequently show the presence of faecaliths which obstruct drainage and predispose to the development of inflammatory changes. The symptoms of these necessarily depend upon their character and extent. With acute inflammation in a single diverticulum they closely resemble those of appendicitis—pain, nausea, and vomiting, localized tenderness and rigidity, and increased leucocyte count. If the diverticulum happens to be situated in the caecum or ascending colon differential diagnosis will be impossible until the abdomen is opened, and because of the mimicry of appendicitis such cases are almost routinely subjected to operation. When the lesion is in the left half of the colon a pre-operative diagnosis can be more readily made. Granting the presence of a diverticulitis one of several results may follow, namely resolution, perforation with resultant diffuse peritonitis, abscess, perforation into a surrounding viscus (bladder or intestine), ischio-rectal abscess, and thickening of the gut wall, mesocolic, and surrounding fat so that obstruction of varying degrees results. Opinion is divided

as to the wisest course to pursue in the presence of an acute diverticulitis. Some prefer to pursue an expectant plan of treatment until complications arise which necessitate surgical intervention, i.e., perforation or abscess while others, notably Erdman advocate immediate operation, consisting of excision of the diverticulum with closure of the opening in the intestine or simple drainage as local conditions warrant. Since diverticula are so frequently multiple, the removal of one that presents acute inflammation affords no immunity to the remaining ones against similar changes. Erdman noted a 4 per cent record of repeated invasions in a series of 52 acute cases treated by operation.

Perforation into the peritoneal cavity produces a diffuse suppurative peritonitis not distinguishable from that produced by other infectious lesions and demands similar treatment. The peridiverticulitis, almost uniformly noted, makes this complication a rare one. Both in free perforations and in those resulting in localized abscess formation attempts at repair of the perforation are in order when local conditions permit. A certain proportion of these are successful while the remainder, like those treated with drainage alone result in fistulae. The latter are usually of small caliber and frequently heal spontaneously. When persistent, secondary closure or resection can be done later after subsidence of the acute reaction lessens the hazard. The subjective symptoms noted in chronic diverticulitis consist of periodical attacks of digestive disturbance with abdominal discomfort and uneasiness and at times definite pain which is usually referred to the site of the infected diverticula. Localized soreness and tenderness can usually be elicited in the region of the diverticulitis and not infrequently a mass can be felt. Roentgenological study constitutes the most important aid in diagnosis, not only locating the site of the lesion but determining as well the extent of the involvement. Many of the chronic cases prove self-limiting presenting occasional periods of more or less activity with long intervals of quiescence. Such instances require no treatment other than supervision of diet with prevention of constipation. The oral administration of

one of the petroleum preparations and the rectal use of oil or other soothing enemata will be of help. If spasticity is revealed by the X ray the addition of belladonna or stramonium to the above regimen will frequently suffice to relieve it.

The complications induced by chronic diverticulitis which demand surgical relief are fistulae and obstruction. The fistulae may communicate with the skin adjacent intestine or bladder. The diagnosis of the former is self-evident the entero-intestinal type will usually be revealed only at operation while the enterovesical variety is evidenced by vesical irritability with the passage of feces and gas per urethram. The latter are easily demonstrated by cystoscopic examination. Operative correction of such fistulae may in some cases prove relatively easy in others it entails difficult and hazardous procedures. The excision of the tract with closure of the opening in the bowel is the ideal. In our experience this can as just stated, be readily done in some instances. In others resection of the thickened distorted bowel will be required. The enterovesical fistulae, if situated high up on both the bladder and sigmoid are accessible to manipulation and correction. If however the opening is located low down in both organs, the difficulty of access combined with the inflammatory infiltration make its correction both difficult and hazardous. In such cases we have elected to do a permanent colostomy with satisfying results. Obstruction may occur in acute diverticulitis as a result of infection and edema when incomplete it not infrequently subsides under the expectant plan of treatment mentioned. When complete an enterostomy proximal to the lesion not only meets the immediate indication but often permits resolution of the diverticulitis to such an extent that no further surgery is needed. Chronic obstruction is due to hyperplasia adhesions and angulation, the so called hyperplastic, stenosing type. Resection, where general conditions do not contra indicate its employment, is the treatment of choice. As with colonic resections for other lesions, experience has shown the two-stage operation to be the safer procedure. Drainage of the bowel proximal to the obstruction allows recession

of the inflammatory phenomena at the site of the diverticulitis and the upbuilding of the patient's vitality both of which enhance the safety of the second stage. The presence of blood in the stool is noted in a small percentage of patients with the obstructive type of diverticulitis. That it is not more frequently present is due to the fact that the pathological changes are so largely extramucosal, being found in the wall of the bowel the mesocolic and surrounding fat. Jones quotes Spriggs as stating that bleeding occurred 3 times in 68 cases of diverticulitis, or 5 per cent and Rankin as stating that it occurred 33 times in 227 cases, or 17 per cent. The presence of blood in the stool which can be demonstrated with the proctoscope to come from above the lower rectum has so great a diagnostic value for carcinoma of the colon as to make the differential diagnosis between carcinoma and diverticulitis at times extremely difficult when this symptom is present. The X ray may show one or more diverticula and the lesion causing the bleeding still be carcinoma. The history the duration of symptoms, the character of defect as revealed by the X ray are all of value in reaching a decision.

A study of the recent literature indicates the incidence of carcinoma developing on diverticulitis at from 1.7 to 8 per cent. This incidence together with the difficulty in distinguishing between carcinoma and diverticulitis in the presence of a palpable mass or defect revealed by the X ray and associated with bleeding from above the lower rectum, makes early exploration a far safer procedure in all such cases than medical regimens which involve delay.

BIBLIOGRAPHY

1. ASCHEWER, P. W. and KARELITZ, I. *Ann Surg* 1930, 91: 573.
2. ARMSTRONG, A. P. C. Sigmoid diverticulitis in a child. *Ann Surg* 1903, 47: 500-5.
3. BUTLER, P. F. and RIVERO, M. Diverticulum of duodenum. *Boston M. & S. J.* 1915, April 9.
4. CASE, J. T. Diverticula of small intestine. *J. Am. M. Ass.* 1930, 75: 1463.
5. CHOMCEL. *Histoire de l'Académie Royale Paris*, 1710.
6. CUBRAL, L. *Bull. Mém. Soc. nat. de chir. Paris*, 1934, 349.
7. COHN, DONALD B. Perforated peptic ulcer of Meckel's diverticulum. *Ann Surg.*, 1931, 94: 256-262.

8. CONLEY H. P. Diverticulosis of colon. South. M. J., 1925, 18 503-6
9. CHILK and PORTMANN. Surg. Gynec. & Obst. 1925 41 615
10. EIDMANN J. F. Diverticulitis of the colon. Am. J. Obst. & Gynec., 1926, 11 600-16
11. HALLOPEAU and HUBERT. Méd. Inf. Paris, vol. 30, 189-194.
12. HAUDERMANN. Arch. Path. Anat., 1896 138 347
13. HELVETIUS, FRANK. False diverticula of the jejunum. Surg. Gynec. & Obst., 1923 37 1
14. HERTZLER, A. E., and GIBSON, E. T. Invagination of Meckel's diverticulum associated with intussusception. Am. J. M. Sc., 1913, 146 365
15. JONES, D. F. Diverticulosis of the colon—its relation to carcinoma. Ann. Surg., 1924 80 425 438.
16. MACLEAN, N. J. Diverticulum of the duodenum. Surg., Gynec. & Obst. 1923, 37 6
17. MACLEAN C. and DURANT E. Rev. de chir. Paris, 1922 11 536.
18. MECKEL, JOHANN FREDRICH. Hand der path. Anat., 1812 1816
19. MAYO W. J. Diverticula of the sigmoid. Ann. Surg. 1930, 93 730.
20. MOLL, H. H. Giant Meckel's diverticulum. Brit. S. J., 1926, 14 176.
21. MORRISON J. H. and FELDMAN M. Ann. Clin. Med. 1926 5 330.
22. MUELLERGRABT E. Arch. f. path. Anat. etc., 1918, 125 125.
23. PALMER, D. W. Meckel's diverticulum with report of case. J. Med., 1928 11 25 27
24. PENDERGRASS, R. C. Duodenal diverticula. Am. J. Surg. 1928.
25. SCHAFFT, G. Arch. f. path. Anat. etc., 1923.
26. Idem. Beitr. z. path. Anat. u. z. allg. Path. 1925.
27. STOUT A. P. Arch. Surg., 1923 6 793
28. SYMMERS. Ann. Surg., 1919 70 183-87
29. TERRY W. I. and MUELLER, F. R. Arch. Surg. 1921 347
30. WATSON C. M. Surg. Gynec. & Obst. 1924 38 67

Discussion

DR. DAVID CHEEVER, Boston. Dr. Abell, in his comprehensive paper has summarized admirably the essential facts about abnormal pouches or diverticula as they occur in the alimentary tract from the oral cavity to the anus. In many situations they are so uncommon as to be rarely encountered even by experienced surgeons, but the possibility of their presence should always be borne in mind, to explain symptoms or physical findings which are puzzling. Meckel's diverticulum, the congenital remnant of the omphalomesenteric duct, is, however, a not uncommon cause of symptoms which are included in the barbarously ungrammatical phrase "acute surgical abdomen," meaning an acute symptom group related to the abdomen and demanding surgical interference, whether or not the exact lesion can be diagnosed. It is only necessary for us surgeons to remember if the obvious cause of symptoms is not revealed by exploration, that Meckel's diverticulum must be searched for and excluded as the possible seat of trouble. Moreover as pointed out by Dr. Abell a peptic ulcer in a diverticulum lined by ectopic gastric mucosa is a well recognized cause of pain, bleeding or perforation. Once a lesion of a Meckel's diverticulum is discovered, the course for the surgeon to pursue is usually self-evident.

The multiple acquired diverticula of the colon, often largely confined to the sigmoid and descending colon are said to occur in 5 per cent of persons 40 years of age and over and since they are always potential and often actual foci of acute or chronic infection, they merit the attention of every physician, not as rarities but as frequent sources of serious conditions. From a state of complete innocuousness they range through symptoms of every grade of severity to conditions so grave that they defy the surgeon's skill. Dr. Abell has spoken of simple diverticulitis, of slow perforation with adhesions and abscess, of fistulous openings into the bladder and other loops of the intestinal canal, of free perfora-

tion with peritonitis, and finally of chronic inflammation with induration and fibrotic thickening which ultimately leads to obstruction. Such conditions as perforative peritonitis, abscess and fistula demand no especial discussion of symptomatology or treatment except to emphasize the great advantage of a preliminary colostomy in the proximal transverse colon, of permanent type, to divert the entire fecal current and permit the diseased segment to be put at rest and cleansed by through and through irrigation thus favoring resolution and subsidence of the inflammatory process and permitting whatever more radical measures seem necessary to be done under favorable conditions.

Special interest attaches to the chronic obstructive forms of the disease. They may closely simulate carcinoma, or indeed be impossible to differentiate, and their successful treatment demands at least as much judgment and operative skill. The symptoms include varying degrees of discomfort, flatulence, pain referred especially to the lower left abdomen, constipation, obstipation, and obstruction. A mild and intermittent pyrexia and moderate leucocytosis may suggest an inflammatory rather than a neoplastic origin. Inasmuch as the lesion often involves a longer segment of the bowel than carcinoma does, a mass is more likely to be palpable—often sensitive to the touch. A barium enema shows a lesion which narrows the lumen—often more extensive than carcinoma, the presence of one or usually multiple small diverticula in the neighborhood are suggestive but of course not pathognomonic, since carcinoma is as likely to affect the colon in the 5 per cent of individuals who have diverticulosis, as in an equal number of normal persons. In instances where the inflammatory lesion is not too extensive, a peculiar saw tooth or accordion-pleated serration of the barium shadow due to deep and compressed folds of the mucosa, is quite characteristic. The finger examining by rectum can

not reach the lesion unless it is felt through the bowel wall as a pelvic mass; the proctoscope, if the process be low enough, reveals more or less occlusion with edema and thickening of the wall, but no ulceration and no blood. The significance of the presence or absence of blood cannot be too strongly emphasized; bleeding is *not* a symptom of diverticulitis since the latter is not an ulcerative process, and if blood is noted as coming from a chronic obstructive lesion above the anal canal the overwhelming probability is that it is due to carcinoma. On the other hand, while it is true that microscopic or chemical traces of blood are present in all cases of carcinoma, the small scirrhous contracting lesion often shows no gross bleeding. The association of carcinoma with diverticulosis or diverticulitis is in my opinion a pure coincidence.

The successful treatment of chronic obstructing diverticulitis of the sigmoid or descending colon may tax all the resources of the surgeon. A proximal transverse loop colostomy should be made to rest completely the diseased bowel and permit lavage. If under this plan the bowel is shown by barium enema to recover its normal contour and caliber and no complications occur it may be reasonable to risk closure of the colostomy and trust that a bland diet, avoidance of constipation and colonic lavage will

prevent recrudescence of the inflammation. Such a happy event rarely occurs, however, and resection with restoration of continuity is indicated. The surgeon's personal experience and preference will determine whether this shall be done by suture or by the Mikulicz procedure; the latter is more applicable here than in carcinoma, since the tendency to slumpy resection is of less account and there can be no grafting of the disease into the wound. The frequent necessity of dealing with adhesions and complications, and the danger of spreading an already existing infection make these operations both difficult and hazardous, and both patient and surgeon may have to be satisfied with, and thankful for, a permanent colostomy. A word must be added about patients with early stages or moderate degrees of diverticulitis. A bland diet, mineral oil to keep the stools soft, and colonic lavage will cause resolution of the process and enable the patient to carry on, in the majority of cases, but both physician and patient should know that a potentially dangerous process is merely being kept under control, and that a recrudescence should have the benefit of a surgeon's opinion.

In conclusion I wish to congratulate Dr. Abell on his interesting presentation of a very important subject—a presentation which bears the authority of very wide experience.

THE REPAIR OF DEFECTS RESULTING FROM FULL THICKNESS LOSS OF SKIN FROM BURNS¹

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IF a burn destroys a large area of the full thickness of the skin the result is an open wound. Unless there is early replacement of lost skin, healing will occur by contractures of adjacent tissues and by "scar" epithelium or permanent healing may never occur (Fig. 14).

The restoration of surface losses and repair of contractures in patients appear complex in many instances but from a study of the requirements of treatment in a fairly large group of patients we have outlined the essential points of care that have usually proved of benefit for these patients.

First The general care is of primary importance and includes the exercise of patience and gentleness, and interest in the patient's welfare by all who come in contact with him. The patient should be kept free from pain and from objectionable restraints, sedatives should be used carefully, and interest in surroundings should be developed especially when the patients are children (Figs. 2D, 3C). Nutrition must be kept up, and transfusions may be required frequently.

Second The local care of the open wounds has for its object the cleaning up of the areas as quickly as possible so that the lost surface may be restored with skin grafts before damaging contractures have occurred. Surgical drainage is best accomplished by the use of saline dressings or by the continual saline bath for 1 to 3 hours a day followed by dry heat or further wet dressings (Figs. 1C and 3C). Many antiseptics (common and proprietary) and gentian violet have been used, but at present we rely on Dakin's solution if anything other than saline is thought necessary.

The use of a firm pressure dressing that is kept moist by irrigation combined with elevation, may be of great advantage for lesions of the extremities, marked improvement may be noted within 48 hours (Figs. 1, 3 and 10).

Pain should be kept down to a minimum when the dressings are removed. They may

be soaked off gradually in a bath, and it is important that some protector shall have been used next to the wound to prevent the granulations from growing up through the meshes. For this, old linen, perforated cellophane like material, or very fine mesh gauze is usually satisfactory so that dressings can be removed even from children with a minimum of discomfort. When cellulitis is controlled, grease dressings (xeroform zinc oxide, or scarlet red) on fine gauze or linen can be used, these allow the patient greater freedom, but they are not used for several days immediately preceding operation. Gentle mechanical cleansing of wounds daily is important, but care should be taken not to disturb epithelization.

Surgical drainage and pressure dressings usually result in wounds with bright red, firm granulations, free from surrounding cellulitis. Bacteriological studies have shown that it is probably easier to get sterile cultures from small wounds than from very large open areas. We have repeatedly grafted wounds when from the appearance of the granulations we have thought them to be ready, and we have had successful takes with a minimum amount of cellulitis, when pre-operative cultures have shown multiple organisms. A thorough Carrel-Dakin technique is undoubtedly an advantage but it cannot replace careful evaluation of the general condition of the patient and of the gross appearance of the granulations and surrounding tissues.

Another important result from the use of the saline bath for badly burned patients is that ordinary secondary contractures will have been straightened out by the voluntary effort of the patient without the use of traction or restraints. Most patients are extremely grateful for the bath and realize their first comfort in it, and we believe that it has occasionally been a life saving measure. There may be a bad reaction to it, however, and there is frequently an elevation of temperature. If any of these

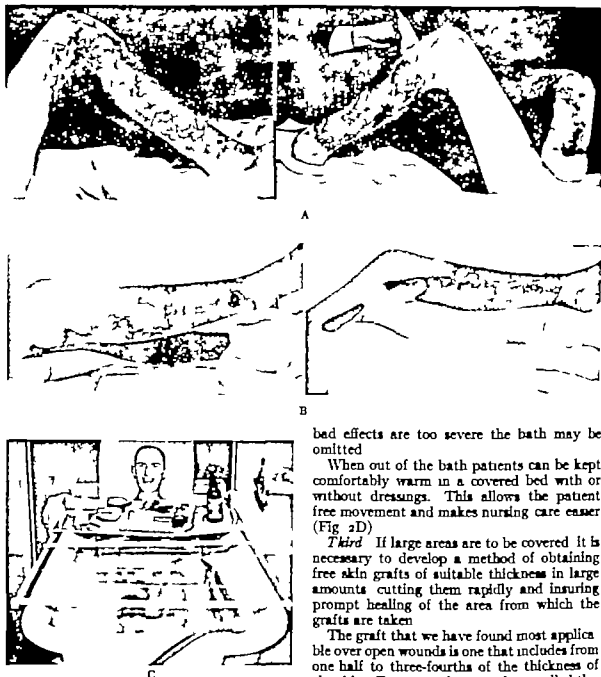


Fig. 1. A, Complete circular burns of both legs with a 90 degree flexion deformity of the knees several months after the burn. B, Legs shown after a few weeks of daily saline baths. The granulations are clean, there is no surrounding cellulitis, the flexion deformity has been completely overcome and the legs are ready for operation. C, Patient in daily saline bath. General health much improved, and he has completely overcome the flexion deformity by active movement without splints or traction of any kind.

bad effects are too severe the bath may be omitted.

When out of the bath patients can be kept comfortably warm in a covered bed with or without dressings. This allows the patient free movement and makes nursing care easier (Fig. 2D).

Third. If large areas are to be covered it is necessary to develop a method of obtaining free skin grafts of suitable thickness in large amounts, cutting them rapidly and insuring prompt healing of the area from which the grafts are taken.

The graft that we have found most applicable over open wounds is one that includes from one half to three-fourths of the thickness of the skin. For convenience we have called this a thick split skin graft to differentiate it from a full thickness graft and from an Ollier Thiersch graft that usually includes little more than the epidermis. It might be called a thick Ollier Thiersch graft (Fig. 4).

By using a sharp knife 18 centimeters long, very large grafts may be cut rapidly and the



Fig. 1. D. Patient completely healed at time of discharge 3 weeks after the last of two operations. Note complete healing of donor sites of split grafts on back, buttocks, abdomen, and thighs.

larger they are the more easily they may be applied, grafts up to 18 by 5 inches may be obtained from suitable thighs. The suction retractor described in 1929 is used routinely, with it fairly large grafts may be cut even from the abdomen (Fig. 5).

These grafts are applied to the area after granulations have been carefully and smoothly shaved off or after any contractures have been fully opened by dissection, or scar tissue has been excised. They are held firmly in place with horsehair sutures all around and multiple mattressing sutures over the surface. Many stab holes are made through the graft to provide for drainage. It is important to note that the removal of granulations causes a good deal of bleeding and that over large areas it must be very carefully done or even omitted if the patient cannot stand the added bleeding. It is a help in preserving blood to have an assistant hold compresses over an area as the following one is being denuded.

The donor areas require careful dressing with a fine mesh gauze impregnated with a thick ointment (xeroform, scarlet red or zinc oxide) and held firmly in place. Healing is usually complete in 10 to 15 days, and we have

on occasion cut three "crops" of grafts from the same donor area (Figs. 1, 3, 9, and 10).

At present autografts are used entirely for these repairs. By using the split grafts wherever possible, the donor areas are preserved fairly well and one is usually able to find skin enough to make acceptable repairs.

Fresh homografts are used very rarely and only when it is thought that the patient cannot stand a long operative procedure and when there is no sign of spontaneous epithelization. Homografts will usually take satisfactorily, but in our experience are always absorbed within 3 weeks. However the few days respite that the patient receives while these grafts are in place may actually be a turning point in his recovery and there may be an increased spontaneous epithelization. The use of delayed homografts stored in the patient's serum and in saline is being investigated. It is possible to use successfully autografts that have been stored for several days, but this fact is not very important clinically especially when dealing with split grafts, for they can be cut rapidly and add but little time to the operation.

In some areas, mainly about the face, the split grafts are applied as "stent" grafts, either a wax or gauze or sponge form being used over the graft which is held in place with mattress sutures from side to side.

Fourth. The care of the grafted area requires a simplified method of applying a pressure dressing and of keeping it moist if neces-



D

Fig 2. A Widespread body burn cleaned up in saline bath with healing to point shown in B in 6 weeks. C Complete function and permanent bearing surface obtained in 3 operations by release of contracture and application of thick split grafts. D Patient shown in a covered and heated bed without dressing and without restraints or splints of any kind. Active motion encouraged and secondary contractures are limited and with early surface restoration function is usually complete. The baby below as shown to illustrate a needless and dangerous method of fixation.

sary. If the wound has been originally quite dirty and refractory to treatment before operation or if there are any reasons to fear a degree of infection that might damage the graft a wet saline dressing with irrigation tubes incorporated in it is put on and pressure is obtained over the area with sea sponges bound

on firmly with heavy gauze rolls. The dressings are kept constantly moist for 4 days at which time the first dressing is changed.

If the area is quite free from contamination a sponge pressure dressing is applied with a few layers of grease gauze over the graft (Figs 6 and 7).



A



B



C

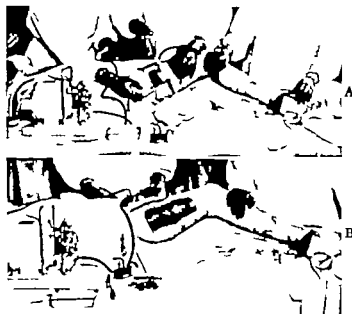
Fig. 3. A Complete circular loss of skin of thigh and superficial burn of hand with secondary contractures and joint fixation. B One month after discharge. There has been total and permanent restoration of the surface with thick split skin grafts with complete function in two operations. During the period of preparation, implantation grafts, fresh homografts and delayed homografts were used in attempts to stimulate wound healing. Note healing of donor areas on other leg. C, The saline bath in this instance was an invaluable aid in reclaiming the patient mentally and in preparing the wound for grafting. There has been much accomplished with occupational and physical therapy of the crippled left hand.



B

C

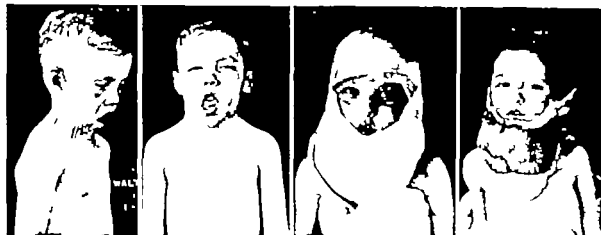
Fig. 4. Thickness of skin grafts. All three grafts cut from the same area from a single patient and photographed under the same magnification. A Average Ollier Thiersch thickness. Most texts state that the skin is taken through the papillary layer but even the thinnest ones usually include some derma. B A thick split or thick Ollier Thiersch graft. The thickness shown here is greater than generally used. It can be roughly graduated between one-third and three-fourths of the full thickness. C, Full thickness graft, not quite all of which is gotten in the field of magnification.



A

B

Fig. 5. A, Technique of cutting graft. The skin is lightly greased with vaseline, the knife is gotten very sharp and a good strong suction is supplied by the pump and delivered to the suction retractor through the tube. The assistant makes countertraction with the soap dish. B Grafts as large as necessary or as the thigh will supply are taken. The graft is shown spread out on the table and should always be clamped immediately to the cover to prevent loss



A

B



C

Fig. 6.

D

Fig. 6. A, Complete burn of neck with wide open-bite of lower jaw resulting from traction on the jaw by scars. B, Sponge pressure dressing after first operation. C, The deformity has been released and the entire front of the neck covered with thick split grafts, shown here at time of first dressing. The sponges have made an accurate cast of the area. D, Final result with complete function and complete spontaneous correction of the open-bite. The contour and smoothness have been effected by putting in a wide full thickness graft directly across the front of the neck. The helix of the right ear has also been restored.

Fig. 7. A, Growth of arm to side from wide skin loss over arm, chest, axilla, and both axillary folds. B, Fixation of dressing after application of thick split grafts. A quilted bed pad is incorporated over the sponge pressure dressing and held with gauze rolls and adhesive. C, First dressing after operation showing the sea sponges as they become molded in place. D, Complete release of the arm has been obtained and a full "take" of the thick split grafts is shown one operation. Jackson extends from anterior

superior spine over flank, chest, axilla and half way down arm. Although none of the scarred surface was removed, it can be seen that the only skin flaps available for closing were small ones over the flank. The triangular inset of skin over the arm is to be noted as important in relaxation. E, Complete function apparent, but close observation shows very tight, heavy scar over hip that makes a general tightness and some hindrance to activity. F, The lack of sufficient skin surface has been corrected in one operation, this has been accomplished by simply opening the scar and dissecting the edges back without sacrificing any surface, and then covering the defect with thick split grafts, as shown.

Fig. 8. A, Deep sinns in scar heavily contastuated. Wide open-bite of lower jaw. B, Result of preliminary opening of sinns and complete release of the deformity. C, Result of application of split grafts in two operations. Final restoration of contour and smoothness to be gotten with a full thickness graft across the front of the neck as in Figure 6.

(Figs. 7 and 8 on opposite page.)

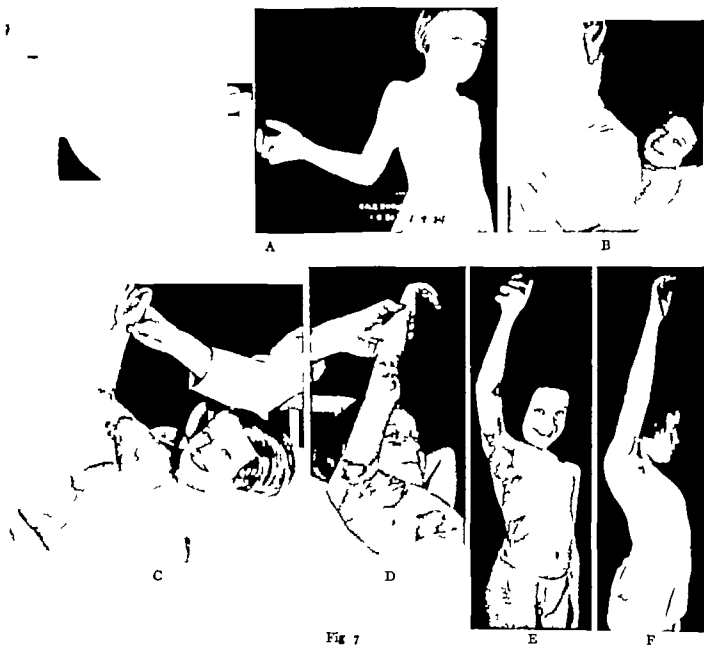


Fig 7

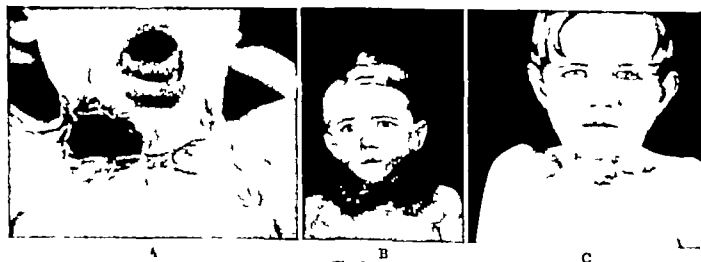


Fig 8.

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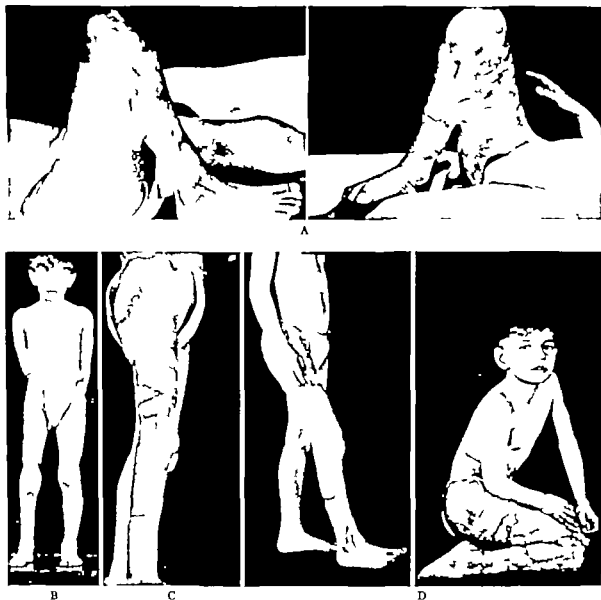


Fig. 9. A, Complete function of leg to thigh one year after burn. B, Restoration, complete and permanent, after 6 months with thick split grafts. The leg was opened at first operation to within 15 degrees of complete extension. The remainder was accomplished by direct skeletal traction applied by Dr. C. H. Crego. The defect was then covered

with split grafts in two operations. Note healing of donor areas on opposite thigh and abdomen. C, Not triangular insert of graft in thigh; this is shown because of its importance in relaxation. D, This photograph which was taken 8 years later shows that there is complete function and no foot drop.

Over many years observation we have proved in our own minds the superiority of the sea sponge as a medium for obtaining pressure over skin grafts and have preferred to develop its use on a simplified plan rather than search further for substitutes. That the pressure be applied and maintained is the

principle, however, and if it is effected with a medium other than a sea sponge the object has been accomplished.

Fifth. In the repair of late burn contractions, free skin grafts can be used extensively and give permanent bearing surfaces in many instances. They often may be substituted for

a tedious laborious use of pedicle flaps that require multiple operations.

If there are sinuses extending down into scar folds that harbor organisms detrimental to the chance of "take" of a skin graft a preliminary opening is done and sometimes a huge open wound is produced. In the grafting of all contaminated open wounds we use the thick split graft rather than a full thickness graft because of the greater assurance of its "take" in such a field (Fig. 8).

If the late contraction is healed so that a clean operation can be done then the use of a full thickness graft can much more safely be undertaken but even here, in many instances the split graft can be used satisfactorily and may even be required if the area to be grafted is so large that the necessary amount of full thickness skin cannot be sacrificed (Figs. 7 and 9).

One patient in the series has had 178 square inches of skin transferred at one time and 48 square inches at another (221 square inches total or 1,381 square centimeters).

In repairing healed contractures all surrounding skin possible is, of course, utilized. If there is dense scarring with marked contracture, it is seldom that flaps can be turned in from the surrounding area the entire mo-

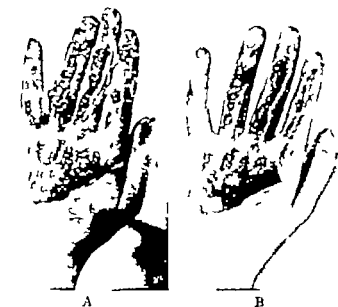


Fig. 10. A, Hand shown 2 weeks after a mangle burn. B, Two days later after saline soaks, saline jelly dressing and gentle débridement.

bilization being one of dissection and release of binding scars. In old cases in which the scar has been drawn out into a web and there is little or no deformity it is occasionally possible to effect the repair by using the web itself. This is commonly called a "Z" or reversed "Z" plastic, however the openings seldom actually resemble a "Z" and the main point to remember is that the two surfaces of



Fig. 10. C, One month later after application of split graft. Patient able to work one week later. D, Four months later showing permanent bearing surface.



Fig

Fig 11 A, Late deformity from wide skin loss. In most cases it is difficult to learn from the history whether or not the tendons have been lost. B and C, Complete restoration in one operation with a full thickness graft, 1 month after operation.

Fig 12 A, Deformity of neck and face from burn scar that extends from arm across axilla and that has pulled skin normally under the jaw clear down to the clavicle. B, Correction of deformity with one full thickness graft let in low down. Surface unevenness left for later correction. C, Completed correction with full thickness grafts done in two stages to a old injury to lower branch of seventh nerve.

Fig 13 A, Burn of scalp from beauty parlor comb. In this region scar epithelium is slow to form and usually gives an unsatisfactory bearing surface with marked tendency to repeated ulceration. B, Restoration done in one operation with a single large split graft.

Fig 14, Failure of healing over 9 months' period. There is a complete failure of spread of epithelium grossly and macroscopically, but activity is evidenced by a marked piling up of dead cells. This patient was burned 10 months before, had been in bed the entire time and had spent \$1,200.00 on one single proprietary ointment recommended for the treatment of burns. He was treated as the patient in Figure 1 with restoration of the open areas on both legs in two operations.



Fig 12



Fig 13

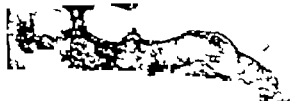


Fig 14.

the web are saved and fitted across each other to obliterate the web. In many cases the use of adjacent flaps or the two surfaces of the web may be combined with free skin grafts to cover remaining open areas. Scar flaps should not be too large because their blood supply may be extremely uncertain (Fig 7).

In some patients who have healing after very widespread burns, there may be no actual deformity but a general tightness of an area with perhaps some limitation of motion of an extremity. These patients frequently need more skin surface, and a release of the general surface tension is effected by simply opening across the tightest portion of the contracted area, allowing the edges to retract, and then filling in the open area with split grafts (Fig 7).

Sixth Burns of the hands deserve special attention because every effort should be put forth to prevent the deep infection that will so rapidly fix tendons and joints and produce deformities that may never be overcome. For deep losses, the first treatment should be active surgical drainage, active movement should be encouraged, the fingers should be dressed apart and the whole hand kept in position of function. The average burn should be ready for grafting in 3 weeks, if tendons have not been exposed, and, frequently, the single application of a split graft may be all that is neces-

sary. If there has been an extensive deep burn, as soon as sloughed tendons are separated and the granulations are clean it is often advisable to "dress" the wound with a thick split graft so that healing may stimulate activity and joint fixation may be limited, then later any necessary thicker repair can be done (Figs 10 and 11).

Seventh The rehabilitation of the patient's activities should be started early, if possible even before surgical restoration is started (Fig 3C). Children usually take care of this themselves but guidance in physical and occupational therapy is always beneficial. Burned hands may require special effort and the use of splints, as notably advocated by Kanavel, Koch, and Mason. In all the working contacts with patients, a firmness of purpose should be maintained that will tend to keep the patient's morale on the highest possible level.

BIBLIOGRAPHY

1. BLAIR, V. P. and BROWN, J. B. The use and uses of large split skin grafts of intermediate thickness. *Surg. Gynec. & Obst.*, 1929, 59: 82.
2. Idem. Early and late repair of extensive burns. *Dallas M. J.*, 1931, 17: 59-70.
3. BLAIR, V. P., BROWN, J. B. and HAMM, W. G. The early care of burns and the repair of their defects. *J. Am. M. Ass.*, 1932, 98: 1355-1359.
4. Idem. The release of axillary and brachial scar fixation. *Surg. Gynec. & Obst.*, 1933, 56: 790-798.



Fig.

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Fig. 12



Fig. 13

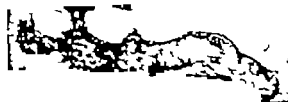


Fig. 14.

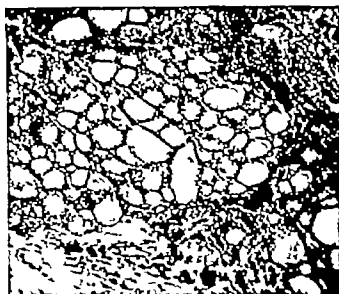


Fig. 1. Thyroid cross-graft in dog, 32 days old, low power

described briefly as follows. Under strict surgical asepsis throughout, tissue is removed from the donor minced carefully into tiny fragments, 1 to 1.5 millimeters in diameter, and planted on a coagulated medium such as is used for tissue culture. After a day or two of observation to insure that the cultures are alive and not contaminated they are transferred to new medium containing serum and plasma derived from the intended recipient of the graft. On this medium they are grown for a period of 2 to 4 weeks, being transferred to fresh medium as often as seems desirable. When ready for grafting a small incision is made through the skin of the recipient, at the



Fig. 2. Thyroid cross-graft in dog, 44 days old, low power

axilla or groin and a pocket pushed open by blunt dissection in the areolar tissue near the large blood vessels. The various fragments of graft are picked up on a pipette containing salt solution squirted into the pocket and the small incision sutured. If the grafts take, they grow slowly in size and after a number of weeks or months restore the physiology of the recipient to normal. This technique at present being used represents a development from many experiments in different directions and on many aspects of the general problem, often resulting in failure, but leading on to better ways of attaining the object. It is, of course, subject to further improvement and



Fig. 3. Thyroid cross-graft in dog, 57 days old, low power



Fig. 4. Thyroid cross-graft in dog, 80 days old, high power

LIVING GRAFTS OF THYROID AND PARATHYROID GLANDS¹

HARVEY B. STONE, M.D. F.A.C.S. JAMES C. OWINGS, M.D. AND GEORGE O. GEY, M.D. BALTIMORE

THE last few years have marked a great stride forward in the treatment of disorders due to deficiency in function of the glands of internal secretion. As a result of the discovery of active chemical substances derived from the glands—thyroxin, parathormone, cortin, etc.—the therapy of myxedema, tetany, and Addison's disease has been given a measure of accuracy and directness entirely new. These brilliant achievements of biological chemistry make it possible to supply from without the necessary substances that the body should produce for itself. The obvious next step in the conquest of these deficiency diseases is to restore to the body this power of producing its own needed substances; in other words, to graft into it a living functioning gland to replace the one that has failed. It is the purpose of this paper to report in brief our work in this field, more extensive details having been published elsewhere.²

After several years of laboratory and clinical studies, which began discouragingly enough but yielded increasingly promising results as time went on, we feel justified in saying with out reserve that we believe successful functioning grafts of thyroid and parathyroid tissue can be made from one dog to another and from one human being to another. As evidence of this we submit illustrations (Figs. 1 to 6) showing photomicrographs of tissue removed for study at intervals of 4 weeks to nearly $\frac{1}{2}$ year after cross-grafting. It is clear that this tissue is living, healthy, and apparently functioning. In further evidence we submit the reports on a number of human cases in which there is reason to believe that cross-grafts have been successful.

CASE 1. Graft of human parathyroid tissue into patient with profound typical tetany following thyroidectomy 18 months previously, which was getting worse in spite of treatment. It is now over a year and a half since the graft was done. This patient is clinically well, has passed through normal labor successfully since the graft operation, and has had a return to normal of her blood chemistry.

CASE 2. Graft of human parathyroid tissue into patient with spontaneous tetany, typical and severe. This case also has been completely successful clinically for a period of a year and a quarter, with return of the patient's blood chemistry to normal.

CASE 3. Graft of human parathyroid tissue into patient with postoperative tetany of severe grade. Duration of time since grafting about 5 months. Patient much better, blood chemistry approaching normal. Graft apparently successful and growing.

There have been 2 other grafts of parathyroid tissue: 1 for postoperative tetany and 1 for spontaneous tetany. In the latter case there was some doubt of the diagnosis. The patient was not benefited by the graft and it has not been repeated. In the first of these 2 cases a graft was apparently unsuccessful after 3 months, so that a second graft has been done. It is too soon to say whether this second graft, now about 6 weeks old, will succeed.

CASE 4. Graft of human thyroid tissue for myxedema after thyroidectomy. This patient has received grafts 3 times, some weeks apart, as much more thyroid substance is required for health than in the case of parathyroid grafts. He has improved clinically, has lost 11 pounds in weight, can work and feel well on a fraction of the dose of thyroid extract formerly required, has a higher basal metabolic rate, and is regarded as a partial success. We hope that with the growth of the grafts in time this success may become complete.

We have also grafted thyroid tissue into several children and one adult for conditions of a complicated nature, part of which was apparently due to deficient thyroid secretion, but in none of these cases do we feel that we can claim success for the graft. It is perhaps unnecessary to point out that no type or method of grafting can reasonably be expected to yield 100 per cent successful results, but the evidence herewith submitted from both animal and human cases seems to us convincing that our method has proved that cross-grafting of these two endocrine tissues can be and has been accomplished.

As to the method itself, the details of which have been published elsewhere, it may be

a part in the success of cross-grafting. Young tissue has a greater "growth potential"—a term of unscientific vagueness but clear enough meaning—than old tissue, and when ever possible should be used as the source of the graft. Also, the recipient is in better condition to support and foster the graft if in general good health than if suffering from a variety of disorders in addition to the specific tissue deficiency for which the graft is done. Then there is the question as to whether a graft can be expected to survive unless the host has a physiological need for it. Halsted suggested that such a deficiency was necessary for the success of the graft and this idea has been referred to as "Halsted's law of deficiency." It is perhaps unnecessary to state that complete surgical cleanliness and avoidance of infection is essential to the success of the procedure.

It will be seen that experimental attack upon the problem of cross-grafting and analysis of the difficulties presented have led to the recognition and understanding of some of the conditions that are essential for success. No doubt further study will extend our knowledge and increase our mastery of this important field. The successful growth of mammalian tissue derived from one animal in the body of another, for an indefinite period of time and with preservation of physiological function is a matter of wide biological interest. Its practical implication in the field of medicine and therapeutics need only be suggested. Whether other endocrine tissues can be successfully transplanted by this or some similar method we cannot say. We do feel safe in saying that cross-grafting of thyroid and parathyroid tissues has been accomplished, both experimentally and clinically.

STATISTICAL STUDY OF DISEASES OF THE OESOPHAGUS¹

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IN the past 10 years, 1,600 patients or 1 of every 161 who have been admitted to the Out Patient Department of the Massachusetts General Hospital, have come because of dysphagia or some other symptom relative to the passage of food from the mouth to the stomach.

A study of these cases should give a reasonably accurate idea of the relative frequency of the various causes of difficulty in swallowing.

The entire series of cases was studied from the clinical, roentgenographic and endoscopic standpoint.

No demonstrable lesion could be found in 143 patients, or less than 10 per cent of the 1,600 patients seeking relief for dysphagia.

METHOD OF X-RAY EXAMINATION

The type of examination varies with the lesion suspected. It is not sufficient to give the patient barium to swallow and merely observe the patency of the food passage. The reaction of the muscles of deglutition, the tonicity of the oesophagus, the activity of peristalsis, and the presence of stasis must all be noted.

If we are to pick up the early changes in the wall of the oesophagus before the lesion is extensive enough to produce obstruction a very careful examination is necessary.

The procedure we have found most satisfactory is first to fluoroscope the patient while he drinks a thin barium mixture. If this is negative a heavy thick paste is given which travels slowly enough for the entire oesophageal wall to be examined. The patient is fluoroscoped while drinking the barium mixtures, in both the erect and prone positions. If these show nothing the patient is again given the thin barium mixture and after the bulk of the bolus has passed into the stomach a film is taken with the patient in the right oblique position.

If the oesophagus is normal, thin lines will be seen on the film which indicate the normal

mucosal folds (Fig. 1). If the oesophagus does not properly collapse upon itself interruptions or widenings of these folds may be noted. This method was first described by Schatzki in his work on the delineation of the mucosa of the oesophagus in which he was able to show varices, small ulcerations, and infiltrations which are entirely lost if the lumen is filled with barium.

FOREIGN BODIES

The trauma caused by the lodgement or passage of a foreign body through the pharynx or oesophagus is a very frequent cause of dysphagia. Foreign bodies were found to be present in 183, or 30 per cent, of all those who were referred as suspicious. This is one oesophageal condition more common in the first decade of life (Fig. 2).

Considerably over 90 per cent of foreign bodies lodge in the pyriform sinuses or upper third of the oesophagus.

Because the majority of foreign bodies lodge in the upper portion of the oesophagus, our routine procedure is to take a film of the neck in the lateral position before the patient is given any barium (Fig. 3). This will reveal the presence of foreign bodies which usually are considered non-opaque such as chicken bones and fish bones. On the lateral view in the average sized patient the oesophagus and perioesophageal structures measure about one-half the width of the trachea.

If the foreign body is not located on the lateral view a search must be made for it with the aid of a heavy barium paste for if present the barium will adhere to it and will not be washed off by subsequent swallowing of water.

We were able to locate all of the foreign bodies in our cases by either the plate or fluoroscopic method.

If there is oedema and scarification of the mucous membrane from trauma in the passage of the foreign body there will be delay in the transit of the barium and a variation from the normal mucosal pattern but one or two swal-

¹Presented at the symposium on "The Oesophagus" before the Clinical Congress of the American College of Surgeons, Boston, October 3-14, 1934.



Fig. 1. Roentgenogram showing barium in the mucosal folds of the normal oesophagus—fine sharp lines parallel.

lows of water will wash off the barium from any such area of abrasion.

When fluoroscopic examination was negative and there were clinical symptoms suggestive of the presence of a foreign body pre-oral examination was carried out which showed that the continued irritation was due to trauma or infection at the site of trauma.

The types of foreign bodies found in these cases, were, in order of their occurrence chicken bones, fish bones, open safety pins, small lead toys, pieces of wood, glass, and a variety of hardware.

CANCER

Of the remaining 878 patients in this series complaining of dysphagia from some cause other than the swallowing of a foreign body, 350, or 40 per cent, were due to malignancy (Table I).

The ages ranged from 30 to 78 years, the greatest number being in the seventh decade (Fig. 4). Men predominate over women 6 to 1.

In this series, malignancy occurred in the oesophagus as follows: upper third, 124 cases, middle third 103 cases, lower third, 132 cases.

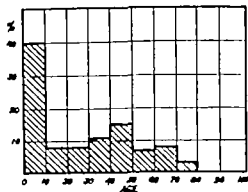


Fig. 2. Graph showing the age incidence of foreign bodies in the oesophagus.

Postcricoid lesions are included in the upper third group. These figures are at variance with percentage of occurrences found by other observers.

Where specimens of carcinoma were taken the types were as follows: epidermoid type 152 cases, adenocarcinoma, 28 cases, non classified, 18 cases.

The majority of patients gave dysphagia and not pain as the initial symptom. Pain is apt to be the first symptom, however, if the lesion arises from the deeper layers of the mucosa and causes mediastinal growth rather than extensive obstruction of the lumen.

The incidence of cancer of the oesophagus is low compared with its occurrence in other parts of the body. U.S. Vital Statistics show it to be responsible for 1½ per cent of all of the deaths from cancer (Table II). Watson, at the Memorial Hospital in New York reports 2.5 per cent. Abel reports cancer of the oesophagus responsible for 5 per cent of all cancer deaths.

Cancer of the oesophagus has been well termed the most melancholy chapter in medicine. It is unfortunate that the average duration of symptoms in patients found to have cancer is over 5 months before seeking relief for by this time they are well beyond any hope of surgical removal or cure by radiation treatment. The only encouraging feature of the matter is that less than half of the patients complaining of difficulty in swallowing in the cancer age, have the disease. The other half for the most part, i.e., those who do not have cancer, are completely cured or greatly relieved by surgical or medical measures.



Fig. 9 Web at the mouth of the esophagus opposite the fifth cervical vertebra

by use of his diagnostic bag proves his contentions beyond doubt. There were 101 women and 34 men in the series, or a ratio of 3:1. The average age at first examination was 40.1 years, the age varying from 16 to 68 years. The average cancer age was 59.2 and the average age for pylorus pouches, 63 years.

FIBROSIS OF THE UPPER END

When infection and consequent fibrosis involves the upper third of the esophagus there is a fusiform narrowing, but no dilatation above the point of constriction because of the ease with which food can be regurgitated back into the pharynx. We found this condition accounted for dysphagia in 96 or 11 per cent, of our series. The symptoms are usually of some years' standing before the patients seek relief. The onset is so gradual that the patient is seldom able to recollect the probable cause.

This condition occurs more frequently in women than men.

The ages of patients were between 26 and 82, but the greatest number were in the fifth decade of life.

On X-ray examination a thick barium paste will show a smooth fusiform narrowing of the upper end of the esophagus (Fig. 8). The esophagus is not deviated from the midline

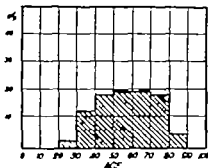


Fig. 10 Age incidence of webs of the esophagus in 14 patients.

as it might be by an external pressure, and the mucous membrane pattern is entirely normal.

The condition produces no pain or distress except the inability to swallow a large bolus of food or in extreme cases, even semisolids or liquids.

On endoscopic examination it may be impossible to pass the large esophagoscope and often the medium sized one will not pass through the stricture. The mucous membrane appears perfectly normal and shows no evidence of previous infection. Because of the fibrosis very little relief is to be gained by dilatation. The psychological effect on the patient of the passage of bougies is one of reassurance, and gives the patient a sense of relief, although the roentgenological picture remains unchanged.

WEBS

The next most common lesion occurs in the mucous membrane with the formation of partial diaphragms of mucous membrane or webs, with either a central or excentric opening. This type was first described by Mosher in 1927.

It is usually possible to obtain a definite history such as trauma from swallowing a foreign body or superficial ulceration of the mouth or pharynx, followed in due time by dysphagia. These lesions are frequently found opposite cervical exostosis.

The roentgenological picture (Fig. 9) is radically different from that of fibrosis. There is an abrupt, sharply defined narrowing at the location of the web. After passing this point the lumen regains its normal outline. This



Fig. 11. Aneurysm of the arch of the aorta causing pressure on the oesophagus—syphilitic ulceration of the oesophagus is rare.



Fig. 12. Lye burns may produce serious strictures at various levels, with normal oesophagus in between. This patient (4 years) had one at the level of the episternal notch and another in the lower third.

picture is so typical and definite that there is little chance of confusing it with other lesions.

This condition existed in 114 patients, or 13 per cent. The average age was about the same as that for fibrosis of the upper end. Eighty four per cent of these were females and 16 per cent males (Fig. 10). Patients are susceptible to exacerbations of their dysphagia due to trauma from rough food. The marked relief that can be given by breaking or stretching this thin diaphragm of mucous membrane by use of instruments through the oesophagoscope is spectacular.

EXTRINSIC CAUSES OF DYSPHAGIA

Extrinsic causes of dysphagia occurred in 31 cases, or about 3 per cent.

The oesophagus may be constricted by external pressure along any part of its course. In one series, 25 out of the 31 cases were located in the upper third of the oesophagus. In the neck region the oesophagus is located in close relationship to a number of important structures, which are often the seat of primary or metastatic malignancy such as tumors of the thyroid and larynx and metastatic masses in the glands.

In this group of cases we have some of the most interesting diagnostic problems. It is only by the most careful and painstaking work, from a roentgenological and endoscopic standpoint, that external pressure can be differentiated from actual involvement of the wall of the oesophagus such as occurs in cancer arising from the deeper glands of the oesophagus for in such a lesion the bulk of the tumor mass is apt to be in the mediastinum with very little showing on the mucosal side.

Burns. There appears to be a decrease each year in the number of cases of oesophageal burns and resulting strictures from the swallowing of acid or alkaline corrosives. There were 40 such cases in our series, or about 0.5 per cent. They were evenly divided between the sexes.

There are twice as many strictures located in the middle third as in the upper part. This is probably due to the protecting covering of saliva in the mouth and pharynx and upper end of the oesophagus, through which the liquid passes rapidly, there is a normal slowing up of ingested matter at about the level of the arch of the aorta.

When the mucous membrane alone is involved there result thin membranous strictures which simulate the webs so often found

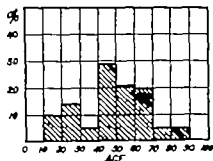


Fig. 13 Age incidence of paralysis of the muscles of deglutition

Twenty five per cent of the stricture cases were of this type. If the mucosa is entirely denuded by the caustic fluid and there is a gluing together of the submucosal structures, there results a tubular stricture varying in length and diameter. Seventy five per cent of the stricture cases had a tubular stricture involving one half or more of the lower part of the oesophagus.

PARALYSIS

Paralysis of the oesophagus is a rare condition and was not encountered in this series, but paralysis of the muscles of deglutition is not uncommon and was noted in 46 patients (Fig. 13). There were 15 males and 31 females, with the average age 47 years.

The symptoms are so difficult to differentiate from those due to obstruction of the upper end of the oesophagus that it seems logical to consider this group of cases in speaking of diseases of the oesophagus.

The paralysis is always of central origin and may be due to any one of various etiological factors: an infection such as poliomyelitis; a localized central hæmorrhage, brain tumor, fracture at the base of the skull with hæmorrhage, and Parkinson's disease.

The muscles of the tongue may be sluggish and unable either to form the bolus properly or to give it its initial push into the pharynx.

The findings are very striking on fluoroscopic examination. Instead of being assisted by normal muscular action the ingested material drops by gravity into the pharynx and completely fills up this area. The pyriform sinuses are entirely flaccid (Fig. 14). The oesophagus



Fig. 14 Paralysis of the muscles of deglutition due to cerebral hæmorrhage. Note the dilated pyriform sinuses. The lack of motion when the patient attempts to swallow is striking.

does not open to receive the bolus as it normally should and the barium remains in the pharynx until expectorated.

Cases of localized cerebral hæmorrhage which presented no other manifestation of their presence accounted for less than half of our cases. The history is characteristic: the condition is first realized when the patient attempts to drink or swallow food and is unable to do so.

After an interval of a few days the patient's ability to swallow returns and the function may be entirely restored. On endoscopic examination with the oesophagoscope, nothing unusual is noted except flaccidity of the pyriform sinuses. There is no evidence of spasm or closure about the mouth of the oesophagus.

POUCHES

Pouches of the oesophagus are rarely recognized during life because they do not produce obstruction and seldom produce symptoms of dysphagia. They comprise less than 1 per cent of our cases.

They are likely to be found during the swallowing of barium in the routine examination of the oesophagus in gastro-intestinal X-ray examination.



Fig. 15. Zenker's pulsion pouch of the lower pharynx, showing barium in the oesophagus, the neck, and the pouch. Symptoms in this case were sensation of lump but little obstruction.

The most common site is the middle third of the oesophagus in the region of the bifurcation of the trachea, and the most frequent type is the traction variety. Traction is caused by the pull exerted on the oesophageal wall by healing mediastinal glands which are also attached to some less yielding perioesophageal structures such as the trachea and dorsal spine. These diverticula are very often conical in shape, although occasionally sacculated ones, which contain food do occur. Rokitsky in 1840 first described the traction type.

The next most frequently described pouch is the pulsion type which occurs in the lower third of the oesophagus just above the diaphragm. Portis reported a case of a pulsion diverticulum which enlarged so much that it produced cardiac embarrassment which was relieved only by washing out the pouch with a stomach tube.

In our series no such severe symptoms were reported but there was substernal distress in 2 cases.

Sacculations of the oesophageal wall may arise above a location of stenosis. Six cases of this type appear in the literature and the seventh case was described by Mosher at the last meeting of the American Bronchoscopic Society.

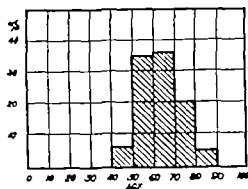


Fig. 16. Age incidence of pharyngeal pouches.

PHARYNGEAL DIVERTICULA

The first case of this type was reported 170 years ago by Ludlow and since then there have been scores of papers written reporting hundreds of cases. The condition accounted for only 32 cases or about 3 per cent of all of our dysphagia cases.

The severity of the symptoms produced by these pouches is in direct proportion to the size of the pouches.

Various theories have been advanced as to the etiology of the herniation of the mucous membrane through the fibers of the inferior constrictor muscle. Jackson believes there is an inco-ordination in the neuromuscular mechanism which results in a failure of the lower part of the constrictor to open when the bolus arrives at this level, thus, momentarily, produces an increased pharyngeal pressure.

The ages of our patients varied from 45 to 83 years and averaged 63 years (Fig. 16). The ages coincide quite closely with the carcinoma cases, which makes the diagnosis of great importance.

In Lahey's report of 21 cases the average was 67 years.

Males predominated over females 4:1. We had 24 men and 8 women.

Diagnosis is made very readily by X-ray examination. The pouch in the well developed case appears to be a continuation of the lower pharynx while the mouth of the oesophagus appears as an opening high up on the anterior wall of the pouch. This condition produces a progressive dysphagia which may result in an inability even to swallow liquids. Swallowing motions are accompanied invariably by gurgling sounds. The pouch may become

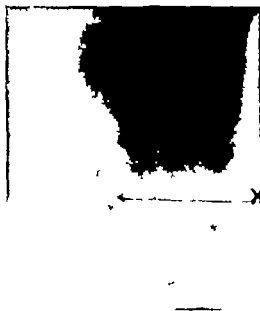


Fig. 17. Ulcer of the lower end of the esophagus with a typical ulcer fleck, x, in an area of scar tissue at the lower end of the esophagus. Note spasm a short way above the ulcer.

filled up with food or air and produce a palpable swelling in the throat which may cause pressure on the laryngeal nerve.

The X ray findings make any error in differential diagnosis quite unlikely.

The treatment is the surgical elimination of the pouch. If this is impossible the esophageal opening may be dilated; this at least benefits the patient psychologically.

ULCERS OF THE ESOPHAGUS

Young adults comprised most of our 14 cases of ulcer of the esophagus. The lesion occurred most commonly in the lower third of the esophagus. Clinically the outstanding symptom is the substernal pain accompanied by dysphagia. The pain is apt to be intermittent as is the case in ulcers elsewhere.

The fluoroscopic examination reveals considerable spasm of the esophagus. After the patient is given barium there is a fleck remaining in the ulcerated area. It may be difficult to confirm the X ray findings with

the esophagoscope because of the scar tissue already formed about the ulcer by the time the patient seeks relief.

These ulcers are prone to occur in islands of aberrant gastric mucosa which are infrequently found scattered about the mucous membrane of the esophagus, more common in the lower third.

Ulcerations of the esophagus from tuberculosis occurred in but 1 patient in our series, who already had had extensive pulmonary and mediastinal tuberculous involvement. Differential diagnosis of this case was made possible by microscopical examination of a portion of the ulcer.

Syphilitic ulceration is extremely rare. Guisez in 3000 cases found but one of which he could be sure. Less than a dozen have been reported in the literature and there were none among our cases.

BIBLIOGRAPHY

1. ABEL, A. L. Esophageal Obstruction. London H. Mifflard, 1929.
2. GONNET, JEAN. De la Syphilis de l'Esophage. *Bull. Acad. Méd.* 1924, Apr. 15, 483.
3. JACKSON, CHEVALIER. *Bronchoscopy and Esophagoscopy*. Philadelphia W. B. Saunders Co. 1917.
4. Ibid. P. 355.
5. KELLEY, A. BROWN. Nervous affections of the esophagus. *Semon Lectures*, 1926. *J. Laryngol. & Otol.* 1927, 43, Apr.
6. LARLEY, F. H. *Surg., Gynec. & Obst.* 1930, 51, 237.
7. LUDLOW. *Medical Observations & Inquiries*. Vol. 3. 85. London, 1767.
8. MORRIS, H. P. Hemorrhage into the esophagus at birth and in the adult. *Laryngoscope*, 1913, Sept., pp. 1-13.
9. Idem. Fibrosis of the terminal portions of the esophagus. *cardiospasm*. *Proc. Internat. Post. M. Assembly North America*, 1931, p. 95-104.
10. Idem. Webs of the esophagus. *Laryngoscope*, 1927, Apr., p. 31.
11. PORTER, M. M. Esophageal diverticulum. *Med. Clin. N. America*, 1931, 5, 53.
12. ROYEN, C. *Lehrb. d. path. Anat.* 1840.
13. Idem. *Oesterr. med. Jahrb.* 1840, 21, 250.
14. SCHATTNER, RICHARD. *Kleinfeldstudien an der normal und krankhaft veränderten Speiseröhre*. *Acta radiol. Suppl.* 18, 1933.
15. United States Government Department of Commerce Printing Office, Washington, D. C., 1935. *Mortality Statistics Reports*, 1929.
16. WATSON, WILLIAM L. Carcinoma of the esophagus. *Surg., Gynec. & Obst.* 1933, 56, 534.

THE OESOPHAGUS¹

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IT is my purpose to review the work on the oesophagus which has been done in Boston and to give the Boston point of view.

Exostosis and webs of the oesophagus Webs of the oesophagus were first put on record in Boston a good many years ago. The cause of webs was at first indefinite, the only ready explanation being an ulceration of two opposing surfaces of mucous membrane caused by appropriate bacteria. I am excluding of course, strictures caused by caustics. Later it was found that exostosis of the cervical vertebrae was often associated with webs of the upper end of the oesophagus. These spurs can be so sharp as to pierce the oesophagus and give bleeding. The first of the cases was discovered in this way. We all know that exostosis or lipping of the cervical vertebrae is common in the orthopedic clinic, and in the majority of such cases there is no difficulty in swallowing. However, in patients who come to the hospital with difficulty in swallowing, we have found that exostoses are a fairly common cause.

Webs can occur anywhere about the upper end of the oesophagus in the pyriform sinuses where the symptoms are those of a small pouch, that is, the patient regurgitates small amounts of food from time to time and has difficulty in swallowing any large bolus of food. They occur also behind the cricoid cartilage.

The webs are placed so high that the obstruction caused by them causes food and fluid to spill over into the larynx, thus producing violent laryngeal spasm. This makes meal time for the patient with a web a time of terror. Such patients therefore, cut their diet to a minimum and lose weight markedly.

The treatment of the web, especially if it occurs in the pyriform sinus is to put it on the stretch by ballooning it with air and then to bite out a generous piece of it. This is followed by the periodical passage of a bougie.

Occasionally a web may make an almost complete diaphragm back of the cricoid. This

generally has a central opening. Such a web is easily divulsed. I remember one patient who had such a web, who had so much difficulty from it that she had to take all her meals in the bathroom.

There is another type of web, sometimes single and sometimes rather a periesophageal thickening for an inch or more. This is found below the cricoid cartilage. We have known about these webs perhaps for the last 10 years. Dr. Macmillan and Dr. Smyth were the first to focus attention on this type. They are easily dealt with by stretching under ether followed by the periodical passage of a bougie, especially by the passage of the mercury bougie which is safe to give the patient for him to pass on himself.

For a long time we were in doubt as to the cause of such webs but, as I shall show later, we now have abundant cause for them in infection of the oesophagus in acute or chronic disease.

Pouches of the oesophagus I should like first to dispose of pouches which spring from the oesophagus at the bifurcation of the trachea and those which occur at the lower end of the oesophagus. Pouches around the bifurcation are not uncommon. They are generally tuberculous in origin, being due to the healing of a suppurating gland which attaches itself to the wall of the oesophagus. So far as my experience goes they give very few symptoms and require little if any treatment.

Pouches of the lower end of the oesophagus I have seen but few of. I have an autopsy specimen given to me by Dr. McGregor which shows three small pouches in vertical line, one above the other. I have seen one or two single large pouches. My experience with this type of pouch has not been sufficient to discuss them from the standpoint of treatment. They might readily give symptoms of obstruction from their size or from twisting on their pedicle.

Pouches of the upper end of the oesophagus or oesophageal hernia Pouches of this type, of

¹Presented in the symposium on "The Oesophagus" before the Clinical Congress of the American College of Surgeons, Boston, October 19-20, 1934.



Fig. 1

Fig. 1 Mesenteric thrombosis. Photograph of the lower end of the esophagus showing sharply defined ulcers. The whole esophagus showed marked infiltration with lymphocytes. 1 Ulcer. (Photograph by Dr. Ireland.)

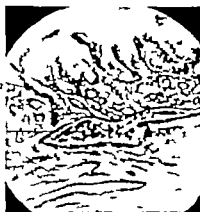


Fig. 2

Fig. 2 Cirrhosis of the liver. The upper figure shows greatly dilated esophageal veins. 1 The lower figure dilated veins, 1 in the stomach. In one place there is a streak of hemorrhage, 2 reaching the surface. This patient died of

hemorrhage. At autopsy the bleeding point could not be found. Often it cannot be determined.



Fig. 3

Fig. 3 Atrophic cirrhosis of the liver. The picture shows 1 cysts projecting into esophageal lumen and cysts under mucous membrane. In chronic infection of the esophagus infected glands and cystic gland ducts are common.

course are fairly common. I believe there is an embryological background to these pouches because they are normal in certain animals, for example the pig. In the pig embryo there are two pouches an upper and a lower. Only the lower however persists. In the embryo of man, in what might be called the pig stage there are two similarly placed pouches. Both however disappear at birth. The function of the pharyngeal pouch in the pig is to house the very large arytenoids peculiar to this animal. The anterior attachment of the esophagus is to the back of the arytenoids in the pig as well as to the back of the cricoid.

Many years ago I found it was common in pouches in man to have the opening of the esophagus asymmetrical, that is, one pyriform sinus is obliterated. This asymmetry of the mouth of the esophagus as I reason it,

puts the tension on the inferior constrictor off center in swallowing and could readily play a part in the formation of the pouch or hernia.

Early in my career I devised an operation for pouch of the upper end of the esophagus, namely I slit the common wall between the esophagus and the pouch. This resulted in immediate relief for the difficulty of swallowing in 6 such cases operated on but the seventh was a tragedy by infection of the mediastinum followed by sloughing of the common carotid. This naturally led to the abandonment of the procedure. For a good many years now I have been referring such cases to Dr. Lahey for the two-stage external operation under novocain. My feeling is that the problem of dealing with this type of pouch is successfully settled. It is a great comfort to have it so settled. This I feel is due largely to



Fig. 4 Atrophic cirrhosis of the liver. The illustration is a cross-section of the oesophagus shown in Figure 3. The oesophagus is riddled with cysts

Dr Lahey Now that we have Dr Churchill at the Massachusetts General Hospital who is specializing in chest and neck work, patients suffering from such conditions are naturally referred to him

Strictures of the oesophagus I have a little to add as to the treatment of such cases. As we know they are more commonly caused by the swallowing of caustics generally one of the commercial washing powders. Owing to legislation originated by Dr Chevalier Jackson washing powder containers dispensing sodium hydroxide are required by law in many states to be labeled *poison*. The public has been educated to the danger of these powders and lye strictures are becoming less common. In a desperate case the best procedure is to put a feeding tube in the stomach and to have the patient swallow a string to be used for retrograde bougienage. Of late I have been using fluoroscopic dilatation of narrow strictures with metal tipped bougies. This is a dangerous procedure and is used only in tight strictures which have to be picked apart slowly and brought to a sufficient size to allow the patient to swallow the string. I have lately had 2 such cases. Dilatation was begun with the bougie tipped with a flexible spiral wire finder. Under the fluoroscope, I found it possible to pick my way through these two strictures, one 4 and one 6 inches in length



Fig. 5 Old peptic ulcer followed by obstruction and peritonitis. The section shows dilated gland ducts and chronic infection of the glands. *l* Lymphocytes in glands.

Foreign bodies As you know almost every type of small hardware finds its way at times into the oesophagus. With the insane sizable objects like forks or spoons occasionally are swallowed. The great point about foreign bodies is to remove them without lacerating the oesophagus because given the right bacteria the posterior mediastinum infects more readily even than the peritoneum or the dura. Every oesophageal examination every passage of a bougie with or without ether, is a potential tragedy. The only foreign body I shall speak



Fig. 6 Adynamic colon. The photomicrograph shows a hemorrhage into the longitudinal muscular layer. *l* Hemorrhage



Fig. 7



Fig. 8.

Fig. 7 Adynamic colon. The first figure shows intramuscular hemorrhage, 1 the second, periesophageal hemorrhage, 1 (See Fig. 6)

Fig. 8 Cholecystitis. The photomicrographs show a great dilatation of the superficial vessels and a pronounced infiltration with lymphocytes. These two findings indicate chronic infection. There is a myoma in the circular layer. The section is taken from the lower end of the esophagus. The first illustration is a low power view showing the full section of the esophagus. The second photograph is a high power view of the myoma.

about is the open safety pin point up. The first safety pin closer I invented years ago after a tragedy following the attempt to remove a very large safety pin, almost a blanket pin from the esophagus of an adult. This closer has been modified and its grandchild is now in successful use in this hospital. The youngest child from whom I have removed a safety pin was 4 months old. In dealing with an open safety pin, point up select the safety pin closer which appeals to you—there are a number of good ones on the market—practice

with it outside the body and then under the guidance of the fluoroscope close the pin and remove it. If this cannot be brought about speedily, the thing to do in my opinion, is to put your pride in your pocket and push the safety pin into the stomach. A try of course can then be made, after the fashion of Jackson, to close the pin in the stomach. Again if this is not quickly successful, the pin should be left to nature. For the first 48 hours it should be watched by the fluoroscope or X ray plate to see that it is moving. If it halts, it generally

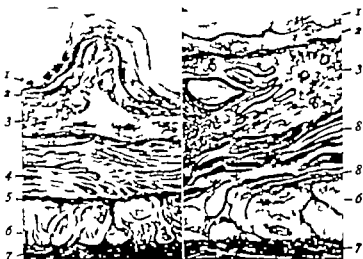


Fig 9.

Fig 9. The first photograph shows a specimen from a normal oesophagus. The specimen shows the normal amount of connective tissue. The largest amount is between the muscularis mucosa and the circular muscular layer. If the muscularis mucosa is absent, the connective tissue is subepithelial. In this specimen there is a small amount of connective tissue between the epithelium and between it and the muscularis mucosa. There is a small amount between the circular and longitudinal muscular layers. The greatest amount is between the muscularis mucosa and the circular muscular layer. Outside the oesophagus, there is also much connective tissue, normally. This is not shown in the section.

Second photograph. Autopsy diagnosis chronic cholecystitis and cholelithiasis and icterus. The specimen of the oesophagus was 11 inches long and bile stained throughout. In the lower third, there were a few cysts in the vertical rugae. The photomicrograph was taken from a section 1 inch above the cardia. The section shows a great increase of connective tissue. The subepithelial connective tissue is increased in amount and is oedematous. The subepithelial vessels are enlarged. The circular muscular layer is almost obliterated by fibrous tissue. Other sections show enlarged and infected gland ducts. All the sections show chronic infection. This specimen is a striking example of fibrosis of the terminal portion of the oesophagus associated with chronic infection of the gall bladder.



Fig 10

1 Epithelium 2 muscular mucosa 3, superficial layer of connective tissue 4 circular muscular layer 5, connective tissue 6 longitudinal muscular layer 7 periesophageal connective tissue 8 fibrous tissue nearly replacing circular muscular layer

Fig 10. Old peptic ulcer followed by obstruction and peritonitis. The photograph shows a fibrous narrowing at the lower end of the oesophagus. Above this, for one half of the length of the specimen the muscles of the oesophagus are much thickened. 1 Fibrous tissue.

stops at the pylorus sometimes straddling it. We had two instances of this. When it was recognized the pin was removed by opening the stomach. Usually the pin leaves the stomach fairly promptly and within a week it is found in the bedpan. I have personal knowledge—and this happened outside the hospital—of but one case in which a safety pin, after it had left the stomach, perforated the intestinal wall and caused a fatal peritonitis.

Carcinoma of the oesophagus. There are 2 types of carcinoma of the oesophagus: epidermoid, or squamous cell carcinoma, and adenocarcinoma. Adenocarcinoma is less common and is found usually at the lower end of the

oesophagus. I have tried all the usual procedures in connection with cancer of the oesophagus, from curettage to X-ray and radium. All my life I have been pursued by cancer of the oesophagus and I have always said the I stand as helpless before it today as I did at the beginning. Within the past 6 months, however, there have been some hopeful results at our hospital with heroic doses of X-ray. In epidermoid carcinoma there have been one or two promising results. No results have been obtained in adenocarcinoma.

I feel that the thoracic surgeon might be called the liver approach. The end of the oesophagus is likely to



Fig. 11. Old peptic ulcer followed by obstruction and peritonitis. This section is taken from the fibrous constriction at the lower end of the esophagus. It shows almost no muscular tissue. 1. Fibrous tissue.

best result from surgery. I expect that the thoracic surgeon will add to his accumulating honors by reporting successful operations of this character in the near future.

Plummer Vincent syndrome. The medical service of the hospital has referred a few patients labelled as having the Plummer Vincent syndrome. Such patients did have a smooth tongue, anemia and a slight difficulty in swallowing. In all of them a careful esophageal history revealed signs of esophageal obstruction for a considerable time that is, from 1 year to 4 or 5 before the appearance of the anemia. The X-ray picture in these patients showed slight web of the esophagus. This was confirmed by examination with the esophagoscope. As far as the cases go which I have seen, I feel that the primary and essential lesion was a web of the esophagus, the anemia being secondary. I have not seen enough cases to be convinced that the disease called Plummer Vincent syndrome is an actual medical entity.

Hernia of the fundus of the stomach through the esophageal opening of the diaphragm was first reported, I believe, by the late Dr. Morrison of Boston. He is the second Boston man

to become a martyr to X-ray burns. Oddly enough the first one, Dr. Walter Dodd, Dr. Morrison assisted for years. In order to make a diagnosis of this condition the patient has to be examined in the prone position. Most of our esophageal examinations are made in the upright position. I have seen but few of these cases and know them mostly second hand.

Up to within a few years ago the common pathological conditions found in the esophagus were strictures due to caustics, malignant disease, and pharyngeal pouches. In the literature there were references to acute infection of the esophagus generally of unknown origin and to ulcers. Tuberculosis was mentioned occasionally but not often, so was syphilis. I have never seen a case of syphilis of the esophagus. I have seen only 2 or 3 ulcerations which were probably tuberculous. I have seen a few cases of pemphigus.

Ulcer of the esophagus. Speaking of ulcer of the esophagus, there is no reason why ulcer should not occur especially at the lower part since this is histologically comparable to the upper end of the stomach, and ulcers of the fundus of the stomach are common. Years ago I learned to be suspicious of my findings with the esophagoscope at the lower end of the esophagus. It is hard to be sure of what



Fig. 12. Central pneumonia. The section shows three thrombosed veins. 1. Thrombosed vessels.

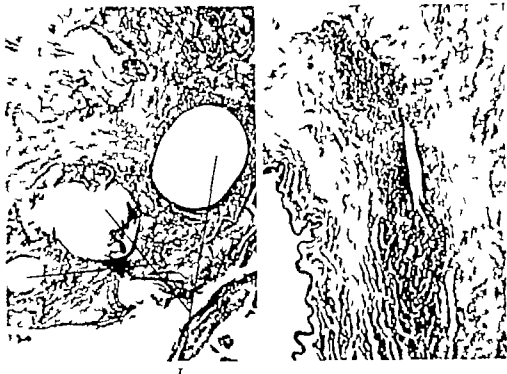


Fig. 13 Infectious thrombophlebitis. The first photograph shows three peri-esophageal abscesses. The second photograph shows an abscess in the esophageal wall near the peri-esophageal abscesses, 1

you see at the end of a 16 inch tube, especially when, in looking for an ulcer, you have to use it edge on. This makes me doubt the frequency of true ulcer as I find it reported in the literature. The slightest maladjustment of the end of the examining tube causes the mucous membrane to bleed and the bleeding point may be easily mistaken for an ulcer. Frankly I have seen very few ulcers of the esophagus of which I could be sure. As I said a moment ago, the natural place for ulcer of the esophagus is at the lower end (Fig. 1). If in a patient with ulcer symptoms the X ray picture shows a small pea like protuberance in this locality, I feel it is reasonable to assume that this is an ulcer. We have only 3 or 4 cases with such a finding.

Cirrhosis of the liver and the esophagus. It has long been known that cirrhosis of the liver interferes with the venous drainage of the esophagus and leads to dilatation of the esophageal veins. In some instances the veins are so large that they will show in the X ray film. Such cases may be associated with hæmorrhage which at times is fatal. It is not necessary, however, that the dilatation of the veins be of the extreme type for hæmorrhage to

occur. The pathologists say that it is often hard to find the source of the hæmorrhage in fatal cases. Figure 2 is of a case in point. Not only are the veins enlarged in cirrhosis of the liver but the ducts of the glands become cystic and are often infected. I have a number of specimens showing the esophagus riddled with small cysts and 2 or 3 specimens in which there were single cystic enlargements fully a centimeter in either diameter (Figs. 3 4 5).

Danger of œsophagoscopy. For years I have maintained that every examination of the esophagus even the simple passage of a bougie is a possible tragedy. I have had a few tragedies with both procedures. The general impression is current among the medical staff of our hospital that œsophagoscopy is too dangerous a procedure and they do not feel safe in referring cases for œsophageal examination. Those of us who are doing œsophageal work have known all along that our percentage of tragedies was low. However, in order to have the actual statistics I had them looked up. During the past 12 years, there have been 938 œsophageal examinations with the œsophagoscope. There have been 19 mortalities associated with this examination and probably



Fig. 14. Old peptic ulcer followed by obstruction and peritonitis. The photomicrograph shows dilated glands in the oesophagus with marked infection. The high power view showed definite abscess in the mucosa with marked infection throughout the whole area.

due to it. This makes a mortality rate of a little over 150 per cent. I defy any medical man who is not simply a bedside watcher to show me any surgical procedure with a smaller mortality rate.

The cases of stricture of the oesophagus numbered 294, with 6 mortalities reported in this group. Webs of the oesophagus numbered 79 with 1 mortality. Carcinoma of the oesophagus numbered 247, 9 mortalities. Foreign bodies of the oesophagus including all kinds, simple and the most difficult numbered 285 with 2 mortalities. Cases of cardiospasm numbered 33 with 1 mortality.

TABLE I.—MORTALITY RATE FOR OESOPHAGOSCOPY

Oesophagoscopies	October, 1917 to August, 1918	Mortalities
Stricture of oesophagus	294	6
Web of oesophagus	79	
Carcinoma of oesophagus	247	9
Foreign body of oesophagus	285	2
Cardiospasm	33	1
Total	938 (15 + %) 19	

Remove the carcinoma cases (these are fatal cases anyway) and the percentage is less than 1 per cent.

The oesophagus at birth. I have specimens showing that the oesophagus can be markedly infected at birth. I have found 1 case of ulcer thus occurred at the lower end. Also I have 2 or 3 specimens showing a backward bend of the terminal portion of the oesophagus. In other words, there is abundant proof that the

oesophagus can be in trouble before birth. In a children's hospital it is not uncommon to find malformations of the oesophagus due to congenital syphilis. In our hospital we do not see this type of case. Speaking of children brings up the question of a congenitally short oesophagus. Here again I have no experience with children to base my opinion on. However I do know that in the adult the oesophagus can be shortened by the contraction of adhesions caused by a lye burn in childhood or to be specific, a young woman of 20 had a lye burn of the oesophagus at 2 years of age. At the present time, that is, after 18 years, the stomach is pulled into the chest a third of the distance to the arch of the aorta. At birth it is not uncommon to find hæmorrhage into the oesophagus or marked periesophageal hæmorrhage. The pediatricians maintain that this is due to asphyxia occurring during delivery. I have a feeling, however, that it may be associated with sepsis.

Hæmorrhage into the oesophagus. Periesophageal hæmorrhage is not uncommon in the adult. Hæmorrhage into the oesophagus itself also is not rare. I have 1 specimen in which hæmorrhage into the lower end of the oesophagus was sufficient to rupture both layers of muscle. This was a septic gall-bladder case and I have it in mind that the hæmorrhage harks back in this case to sepsis. (Figs 5 and 6.)

Narrowing of the cardia at birth. I have 3 specimens showing marked narrowing of the cardiac end of the oesophagus at birth with dilatation of the oesophagus about the strictured area. Congenital narrowing of the pylorus has long been known. If the operative procedure for the treatment of congenital stenosis of the pylorus should in any instance prove unsuccessful the surgeon has a ready alibi in the possible presence of a narrowing at the cardia as well as at the pylorus.

Myoma of the oesophagus. Myoma of the oesophagus was new to me up to a few years ago. I have lately accumulated 4 or 5 specimens of this condition. It has been reported in the literature but is exceedingly rare. It is important only from the fact that should the myoma grow after the fashion of these tumors in the uterus it could easily be a cause of trouble. (Fig 7.)



Fig. 15 Atrophic cirrhosis of the liver. The vessels throughout this oesophagus were greatly dilated. The photomicrograph shows a gland which is adherent to the oesophagus. Over this the oesophageal muscles are replaced by fibrous tissue. On the opposite oesophageal wall, the enlarged superficial vessels are surrounded by dense fibrous tissue. 1 Muscle fibers 2 fibrous tissue 3 gland.



Fig. 16 General peritonitis. The photograph shows many patches of exudate.

Septa of the oesophagus A number of years ago I came across examples of partial transverse septa in the lower portion of the oesophagus. I found them only in the adult. They weaken the oesophagus by making a band of scar tissue partially encircling its lumen. I feel that they hark back to infection spreading along the sheaths of the blood vessels from without in. When they are multiple they divide the oesophagus into segments. Their clinical importance lies in the fact that if they engage the point of a bougie or the end of the oesophagoscope they might easily lead to a rupture.

Infection of the oesophagus in acute and chronic disease Early in my career in dealing with cases of so called cardiospasm I became convinced that spasm played a minor part in cases as they came to our hospital. Under the fluoroscope there are generally no signs of peristalsis, therefore, of course no signs of spasm. In the last 10 years Dr Macmillan and I cannot have seen more than 8 or 10 cases in which spasm was a prominent feature. As I have just said, in most of our cases there is no spasm demonstrable. Examination with the oesophagoscope convinced me that many of these cases were really cases of stricture of the terminal portion of the oesophagus. I found that in many of them the stricture consisted of only a slight gluing together of the

vertical folds which are so prominent in the terminal portion of the oesophagus. At first I was at a loss for a cause of these strictures. Then I began to find in autopsy specimens, especially in specimens of gall bladder infection, that the terminal portion of the oesophagus was infected and fibrosed. One striking instance of this is shown in Figure 8. I have not had many autopsy specimens from patients who died of cardiospasm. My friends however, in different parts of the country have contributed a few so that including a case or two of my own I have been able to examine the oesophagus in some 5 cases. In all of the specimens there was a fibrosis of the terminal portion of the oesophagus associated with a disorganization of the musculature. The oesophagus above the terminal portion, that is, in a long standing case showed fibrosis also but to a less extent. This made me feel that the essential lesion in cardiospasm is a fibrosis of the terminal portion of the oesophagus due to infection from neighboring organs, especially the gall bladder and the thorax. (Figs 9 and 10)

The frequent finding of webs at the upper end of the oesophagus and below the cricoid cartilage not associated with cervical exostosis left me in the dark as to their cause. Then came the finding that the oesophagus can be infected in acute disease as well as in chronic—



Fig. 7 General peritonitis. The photomicrograph shows an infected superficial ulcer over which there is a marked exudate.

for example in pneumonia pyemia and chronic nephritis (Figs 11 12 13). A further finding was that in chronic infection of the oesophagus and in the degenerative diseases like arteriosclerosis there is marked increase

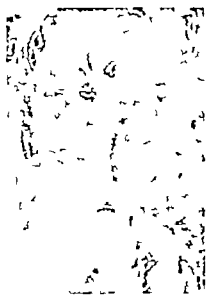


Fig. 18 Mesenteric thrombosis. This photomicrograph shows a superficial ulcer of the oesophagus. Other sections showed chronically infected glands. In one section there was a blocked and infected duct which had broken down into an abscess.

in the fibrous tissue of the oesophagus, in many cases amounting to an obliteration of parts of the circular or longitudinal muscular layers. It became evident, therefore, that the oesophagus could be infected not only from without and from the blood stream, but probably could be infected from within by way of the glands. In other words, it is extremely common in chronic infection to find an increase of the subepithelial connective tissue of the oesophagus. These findings, plus the fact that periesophageal hemorrhage and hemorrhage into the musculature of the oesophagus occur give I feel abundant cause for webs or strictures of the oesophagus at any part of its course. It becomes unnecessary therefore, to rely on spasm especially at the lower end of the oesophagus as the chief cause of oesophageal obstruction (Figs 14 15 16).

Cardiospasm or fibrosis of the terminal portion of the oesophagus. I feel, as I just said that spasm plays but a minor part in the condition commonly known as cardiospasm. I have had a sufficient number of autopsy specimens to prove to my satisfaction that the essential lesion is a fibrosis of the terminal portion of the oesophagus in the region of the



Fig. 19 Acute infection. The photomicrograph shows that the epithelium is lacking. In the subepithelial tissue the fibers in places turned to fibrous tissue: 1 Fibrous tissue 2 longitudinal muscle layer 3 solitary follicle 4 fibrous tissue 5 circular muscular layer.

crural canal. The obstruction may be initiated by a fibrosis of the edges of the crura, a perioesophageal fibrosis in the crural canal or a fibrosis in the oesophagus itself confined to the subepithelial connective tissue or a fibrosis involving one or both of the muscular layers and destroying the greater part of the musculature.

Next in importance to the fibrosis which is due to infection of neighboring organs, is a backward bend of the terminal portion of the oesophagus. I have mentioned finding this at birth. I cannot give the cause unless again it is an old inflammatory process. When fibrosis of the terminal portion of the oesophagus has existed for any considerable time this backward bend or trapping of the oesophagus is a constant finding and it is this backward bend associated with a vertical twist of the oesophagus which keeps the obstruction going. For instance, after the terminal portion of the oesophagus has been dilated a few times the patient has marked relief, but under the fluoroscope there is practically always a fluid level at or near the arch of the aorta. This



Fig. 21. Coronary thrombosis, chronic infection. The photograph shows a loss of epithelium in the lower third of the oesophagus. The microscopic slides showed an infiltration of the lymphocytes where the epithelium is lacking. The oesophagus, therefore, shows chronic infection.

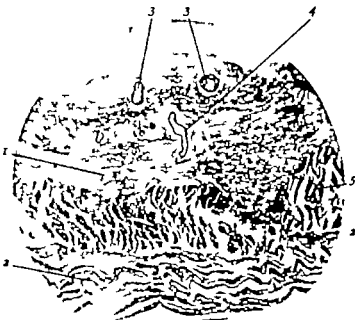


Fig. 20. Acute infection. The photomicrograph shows that the epithelium is lacking. There is a subepithelial thickening due to a deposit of fibrin. Two gland ducts, 2, show hypertrophy of the epithelium which occludes one and almost occludes the other. 1. Fibrous tissue. 3. longitudinal muscle. 4. gland ducts. 5. dilated ducts. 5. circular muscle.

of course, is due to continued obstruction. Both Dr. Macmillan and I firmly believe this recurring obstruction is due to the backward bend just mentioned plus a vertical twist. Spasm, of course, would do the same thing if



Fig. 22. Arteriosclerosis, chronic infection. The section shows a slight infiltration of Auerbach's plexus with lymphocytes. I have found a similar infiltration in this series of specimens, perhaps five or six times. I have not yet found an infiltration with polymorphonuclear leucocytes. I still think that involvement of Auerbach's plexus in cardiospasm is a secondary and not a primary affair.



Fig. 23, above. Passing the diagnostic bag. The position of the instrument table, the patient and nurse, and the vertical fluoroscope are shown.

Fig. 24. Passing the diagnostic bag. In the first figure the roentgenologist is about to take a plate. In the second figure the diagnostic bag is in place, the assistant is inflating it, and the operator is watching the dilatation on the fluoroscopic screen.

we could find evidence of it in these cases. As I have said before, we have been unable to do this (Figs. 17, 18, 19).

When the diaphragm descends and the esophagus is watched under the fluoroscope it is seen to close. It opens when the diaphragm ascends. The point of closure is always at the beginning of the crural canal. This is the place where the diagnostic bag uniformly shows a fibrotic narrowing. In these cases the X-ray film shows at the beginning of the crural canal either an annular constriction which is more marked on the left than on the right due to the large left crus, or it shows a waist-like constriction.

Examination of the esophagus by fluoroscopic sight. After modifying the Sippy bag by stripping it with barium lines and tipping it with a spiral wire flexible finder it became possible not only to examine the terminal portion of the esophagus by sight but to dilate it by sight. The modified Sippy bag can be used for diagnostic purposes and for dilating the esophagus. In my work this instrument has proved to be the greatest advance in esophageal manipulations which I have tried for the past 10 years.

Barium pictures of the lower end of the esophagus. In the typical case of fibrosis of the terminal portion of the esophagus, this organ is

seen to come to an awl like point at the beginning of the crural canal, and seems to be absolutely closed. However in the great majority of cases the flexible tip of the diagnostic bag, which has a diameter of a No 30 French, with a little manipulation can be made to pass into the stomach. Furthermore in a certain number of cases a mercury bougie which is half again as large as the tip of the flexible finder will pass into the stomach. When I first came upon these findings they were rather startling to me. It is because the larger mercury bougie will pass in so many cases that many medical men hold to the spasm theory as a cause of the condition under discussion. However, if the diagnostic bag is passed in these cases as I have done repeatedly, the plate will show the typical fibrotic narrowing (Figs. 20, 21.)

Treatment of fibrosis. The first procedure after gaining the patient's confidence and getting a preliminary X ray plate, is to pass the diagnostic bag to locate the position of the fibrosis and its amount, and to begin the dilatation. In the usual case 3 or 4 dilatations with a pressure of 3 or 4 pounds at intervals of 2 or 3 weeks, will dilate the fibrosis sufficiently to do away with most of the difficulty in swallowing. When the oesophagus can be dilated to normal that is, up to 1 inch, under the pressure given above, the patient is instructed in the use of the mercury bougie and given one to use himself. In the beginning he generally passes the bougie once a day for a month or two and then gradually lengthens the interval. At first when the patient returns for observation and dilatation there is a fluid level at or near the arch of the aorta, showing that the backward bend plus the vertical twist keep up a certain amount of obstruction. A time comes, however when the effect of the dilatation is permanent and the fluid line disappears. In other words the patient comes in for examination with the oesophagus empty. The majority of cases of fibrosis of the terminal portion of the oesophagus can be successfully handled in this manner. When the condition has existed for as many as 30 years (I have such a patient), the oesophagus is markedly dilated and sags decidedly to the right. The terminal portion bends to the left and lies

horizontally on a flat motionless diaphragm. Just before the oesophagus gains the stomach it bends in goose neck fashion back to the right. In other words the oesophagus has two bends. These cases are dangerous to handle with the bag unless extreme care is used. Often it requires great patience to coax the spiral wire finder into the stomach and in some of the cases the fibrotic opening is so narrow that it will admit only the tip of the bag. In these old cases the oesophageal wall is extremely thin so that it is better, at least for a novice to have the patient swallow a string and to use this as a guide to pass the bag. Furthermore, in these cases unless the bag can be manipulated into the stomach either by sight or by the help of a swallowed string, I feel that the operation of anastomosing the terminal portion of the oesophagus to the fundus of the stomach is the coming method of treatment. A number of such operations have been done in England and at least 2 in the Massachusetts General by Dr Churchill. The difficulty in all work on the lower end of the oesophagus by the abdominal route up to the present time has been the inadequate and restricted surgical approach. However, by turning up the left lobe of the liver and mobilizing the lower end of the oesophagus Dr Churchill demonstrated that the operative field can be much enlarged, and in the case in which I saw him use this procedure he had ample room to work. This is a great advance in operative technique.

Oesophageal instruments. In speaking of safety pins I have mentioned the safety pin closer which originated here in Boston. It is one of the most positive that has yet been devised and is practically fool proof. The oval oesophagoscope with the ballooning attachment also originated here; this too appeared a good many years ago. It is in constant use today. It is a great help in locating the opening of eccentric strictures and in making small new growths of the oesophagus visible. It is also useful in locating the oesophageal opening at the cardia in advanced cases of fibrosis where the oesophagus bends markedly to the right and is greatly dilated so that the folds make it very hard to find the opening into the stomach until the oesophageal walls are put on

the stretch by ballooning. I have already spoken of the diagnostic bag striped with barium and tipped with the spiral wire finder. By introducing the bag under the fluoroscope we can watch the finder turn dead man's curve and see when the end of it enters the stomach. The present finder has a very heavy end which more or less automatically falls into the stomach. It is only when the finder is well in the stomach, of course, that it is safe to carry the bag down.

The hollow bougie with the flexible metal staff is the most recent addition to my armamentarium and my feeling is that it will prove one of the most valuable, especially for those who are not doing many oesophageal examinations. It occasionally happens, in beginning the treatment of a patient with fibrosis, that the finder will readily enter the stomach but the tip of the diagnostic bag will not. In these instances the hollow bougie with the flexible metal staff is especially useful. Suppose the oesophagus is markedly bent to the right in such a case the flexible bougie fails to follow this bend. Without the flexible finder it is very dangerous to pass this curve. The flexible finder will take the curve readily and you see it make the turn under the fluoroscope. When the finder has been manipulated into the stomach the flexible metal staff is inserted. This straightens out the bend of the flexible bougie and the operator has a straight and safe shot through the cardia. Bougies of any size can be fitted with the flexible finder so that after the fibrosis has been dilated sufficiently with the diagnostic bag bougies of large size equipped with the finder can be passed in place of the bag.

Speaking of dead man's curve, this is the place where the tip of the ordinary flexible bougie will not make the turn; hence it is the favorite site for perforations. The blind passage of the old fashioned elastic bougie has been accountable for many deaths and since the perforation almost always occurs at the point just mentioned this place has been aptly named dead man's curve.

Metal tipped bougies. Recently I have had two desperate cases in which the oesophagus was strictured to the diameter of a thread for about 4 to 6 inches. The attempt to pass a

thread in each case failed. Examination under ether gave the location of the oesophageal opening which in both instances was eccentric and at the bottom of a sizable pouch. It was not justifiable to do more under ether than locate the oesophageal opening and to find its size. The attempt to pass a bougie would probably have resulted in a fatality because the operator could not tell where the far end of the bougie was going. Under the fluoroscope however a small bougie with a small flexible spiral wire finder ending in a small olive was inserted in the strictured oesophagus making a small gain each time. This was always done under the guidance of the fluoroscope. It is a nerve-racking and dangerous performance. In both of these patients the bougie finally picked its way into the stomach, and then the swallowing of a thread was successful. Both patients were being fed through a gastrostomy fistula. Following the successful introduction of the thread, retrograde bougienage was carried out. At the present time a No. 30 bougie passes in one case and a No. 28 in the other.

SUMMARY

In addition to the old finding that fibrosis of the oesophagus, especially of the terminal portion is the result of infection from contiguous organs, it has been shown that fibrosis of isolated areas is fairly common especially in such chronic infections as arteriosclerosis. In infections of the blood stream the oesophagus is often involved to the extent of ulceration. In acute infections (pneumonia) the oesophagus may be infected. Chronic infection as shown by an infiltration of lymphocytes under the epithelium and in the glands and about the gland ducts, is also common. Dilatation of the subepithelial blood vessels is an almost invariable finding in diseases such as cirrhosis of the liver which impede the venous circulation. I have stated in previous papers that cirrhosis of the liver and infection of the gall bladder are among the chief causes of infection of the oesophagus. As autopsy specimens of these conditions accumulate this fact is becoming more and more evident. Hemorrhage into the muscular layers extensive enough to disrupt them may occur when there is back pressure on the oesophageal ves-

sels. The glands of the oesophagus are especially liable to infection, and are probably the chief route by which the oesophagus is infected from within. One form of solitary follicle is simply a collection of lymphocytes following a gland duct to the surface. To recapitulate the oesophagus can be infected from within

and from without, and is often infected in both acute and chronic disease. In the oesophagus fibrosis follows infection, as it does in other organs of the body. As the oesophagus is so frequently infected, there is abundant cause for strictures or fibrosis to occur in any part of this organ.

OESOPHAGEAL SURGERY¹

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From the Surgical Services of the Massachusetts General Hospital

SURGEONS are fond of referring to the oesophagus as one of the 'last frontiers of surgery' and are apt to imply that its conquest and development lie "just around the corner." Our profession does not retire from marginal lands as easily as the political economists do, or the quest would have been abandoned long ago. Fortunately we have yielded a 99 year lease on the "fishing" and 'film' rights in this territory to an energetic group of specialists, and as the previous papers attest the fishing has been good. The surgeon who professes any interest in the furtherment of knowledge concerning diseases of the oesophagus should either "fish or cut bait" so let us "cut bait" for a few moments and review the results of a limited personal experience in this difficult field.

CARCINOMA

The challenge of malignant disease has been second only to the exigency of wounds of battle in leading the surgeon to extend the boundaries of his science. Nearly every surgeon of experience has considered the problem of carcinoma of the oesophagus and many have tried out their ideas at the operating table or in the experimental laboratory. It is needless to recount the successes—they are so few that they are known by name as 'Torek's case' or 'Eggers' case.' The most recent is 'Turner's case' (8). I shall briefly state my own disappointing experience with the operative treatment of carcinoma of the oesophagus.

Two patients with hypopharyngeal carcinoma (Trotter's female type) have been operated upon by the lateral approach and the oesophagus reconstructed by a skin flap after the method of Trotter. In both instances the continuity was re-established as evidenced by bougienage and the incision completely healed. Following the operation neither patient could swallow anything except small amounts of liquid, due to the destruction of the muscles at the pharyngo-oesophageal junction that play so important a rôle in the mechanism of swallowing. One patient died of recurrence in less than a year, and the other is now in a terminal stage with cervical lymph node involvement. Although the exposure seemed adequate at the time it is probable that the transthyroid approach described by Orton may be more satisfactory. The failure of the patients to regain the function of swallowing after such an elaborate plastic procedure is disheartening.

The tumors of the middle third of the oesophagus that I have explored have invariably proved inoperable.

In my opinion tumors of the lower third of the oesophagus, other things being equal, offer the best opportunity for successful radical surgery. Again, several have been explored and found inoperable. In two instances, however, the procedure described by Sauerbruch was found thoroughly practical. Nevertheless, both patients died of mediastinitis, one on the tenth day and the other on the second. This operation entails an

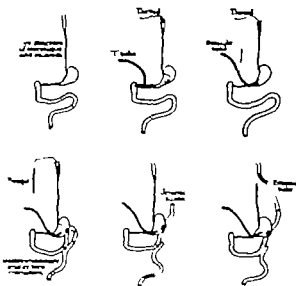


Fig. 1. Successful steps in the treatment of a severe lye burn of the esophagus and stomach

extrapleural approach with the stripping of the diaphragmatic pleura from the muscular layer of that organ. After exposure and mobilization of the growth the diaphragm is cut radially to the esophageal hiatus and the stomach drawn upward into the retropleural space. After the esophagus is severed at the cardiac orifice and the stomach is closed the segment of the esophagus containing the growth is devitalized by a crushing clamp and tight ligature and implanted in the stomach by a modified Witzel procedure. The bulbous growth placed in the lumen of the stomach serves temporarily to ease any undue tension on the suture line and is ultimately digested by the stomach juices. While the operation appears to be a practical one and the exposure excellent and not overly difficult, the operation is probably too extensive when carried out as a single stage procedure.

Patients with carcinoma at the lower end of the esophagus should almost invariably be subjected first to a laparotomy since not infrequently the growth involves the cardiac end of the stomach, the adjacent lymph nodes and frequently the liver. At this stage a gastrostomy may be performed if the growth is inoperable. I would propose therefore, that a laparotomy precede the operation described above and if no intra-abdominal extension of

the disease is found that the cardiac end of the stomach be mobilized by cutting the left gastric artery and the gastrophrenic omentum—a maneuver that is difficult from the retropleural approach. A jejunostomy rather than a gastrostomy may then be performed and the remainder of the operation described above be carried out at a second stage.

As an alternative we must consider in this type of growth the 'pull through' method that has now been successfully performed by Mr. Grev Turner (8). It carries the disadvantage of requiring the construction of a subcutaneous esophagus, but may very well prove to have advantages that outweigh this factor.

STRICTURES

The construction of a new esophagus from the skin of the thorax by the method of Rovsing (5) is a surgical feat that will almost certainly have increasing use in the future. It has been described chiefly in connection with impassable lye strictures but also finds application following resection of the esophagus for carcinoma. Although I have not had the opportunity to complete this operation, the following case history shows the circumstances under which it may be applicable. It also illustrates the complications that may result from extensive chemical injury to the stomach and a method of operative relief.

(1521 L.G. (Fig. 1). On October 10, 1931 a housewife, aged 31 years, accidentally swallowed a cup of lye solution. Three weeks later she was referred to the Eye and Ear Infirmary at which time she was able to take only small amounts of water and milk by mouth. Under observation she showed a rapid and progressive loss of weight and developed neurological symptoms attributable to deficient diet.

On November 21 esophagoscopy was performed by Dr. Tobey. The mouth of the esophagus was found closed by fresh, fibrous adhesions preventing the passage of the esophagoscope. The smallest esophageal bougie (No. 15) could not be passed.

On December 10 laparotomy was performed with the intention of establishing a gastrostomy. The stomach was found to be small, oedematous and adherent to the pancreas. The thickening and induration of the stomach extended downward from the cardiac orifice and included the pylorus and the first portion of the duodenum. There were many fresh adhesions from a perigastric inflammation. An incision was made into the stomach just above the pylorus and the wall was found to be 1 centimeter in

thickness. The layers of the gastric wall could not be identified. The stomach itself contained brown foul smelling fluid similar to that which the patient had been expectorating. A No. 24 T tube was inserted, one end extending upward to the cardia and the other through the pylorus into the duodenum. After a very stormy course the maniacal symptoms arising from the deficient diet subsided and the patient's condition improved.

X-ray studies on December 30 showed almost complete obliteration of the esophagus below the larynx, a small area of intact stomach at the cardiac end, and a free flow of barium into the duodenum through the T tube. On January 19 the patient was able to swallow 3 yards of silk thread. This could not be recovered through the T tube so the tube was removed bringing the end of the thread with it. An attempt was made to reinsert a catheter into the duodenum under the guidance of the fluoroscope but was unsuccessful.

On February 9 a No. 18 French bougie was passed through the gastrostomy opening to the mouth. Increasing difficulty was found in retaining the gastrostomy feedings and the capacity of the stomach seemed to be not over 3 ounces. During the next 2 weeks the patient lost ground steadily apparently due to increasing pyloric obstruction.

On March 3 laparotomy was performed and a small pouch of stomach at the extreme cardiac end was dissected from the diaphragm and the left lobe of the liver. Its capacity was probably not over 3 ounces. An antecolic and antiperistaltic gastrojejunostomy was performed without clamps. When the stomach was opened it was not possible to identify any outlet toward the pylorus, as this end of the stomach had contracted to the size of a No. 22 catheter entering through the previously made gastrostomy opening. An entero-enterostomy between the 2 loops of the jejunum was also established. Feeding was continued through the gastrostomy opening and in 2 weeks bougienage was again instituted. The patient was then discharged to the Eye and Ear Infirmary for repeated dilatations of the esophagus. The dilatations were quite painful but a No. 20 French bougie was passed at weekly intervals.

In July 1932 the patient was readmitted to the hospital for severe stomatitis. At this time the patient could swallow some milk but was depending for the most part upon the gastrostomy tube for feeding.

In September she was readmitted to the hospital still depending upon her gastrostomy feeding. Her general condition was much improved although the anemia had increased somewhat.

On September 29 esophagoscopy was performed by Dr. Campbell Smyth who reported a stricture 6 inches from the upper teeth that accommodated only a No. 15 filiform bougie.

On October 13 under local anesthesia the esophagus was exposed in the neck. It was found to be thickened and indurated. It was completely severed



Fig. 2 Patient with external (rubber) esophagus.

at a level of 2 inches below the upper border of the sternum and the lower end of the upper portion brought out to form an artificial stoma in the neck, as the first step toward the reconstruction of an external esophagus. This upper portion of the esophagus was then dilated by retrograde bougienage to accommodate a No. 32 French bougie. The patient was again discharged from the hospital returning on January 6 1933. At this time a laparotomy was performed and the loops of the gastrojejunostomy identified. One limb of the jejunum was severed just above the entero-enterostomy and its free end carried externally through a skin tunnel to a level above the nipple. The bowel sloughed to the level of the costal arch but at that point a good jejunal stoma was established. The cervical esophageal stoma was then connected to the jejunal stoma with a large, soft, rubber tube (Fig. 2) and by March, 1933 the patient was able to eat without difficulty a liberal solid diet. The gastrostomy tube was still kept in place. The patient refused further operative procedure at this point because of her satisfaction with the external rubber esophagus and she was discharged from the hospital with advice to return for observation and the construction of a skin tunnel esophagus.

Although attempts were made to keep track of the patient through the district nursing association no further co-operation was obtained from the patient or her family. Her alcoholic habits were resumed and she was ultimately taken to a local hospital in a semicomatose condition and died. At least she had the satisfaction of drinking herself to death.

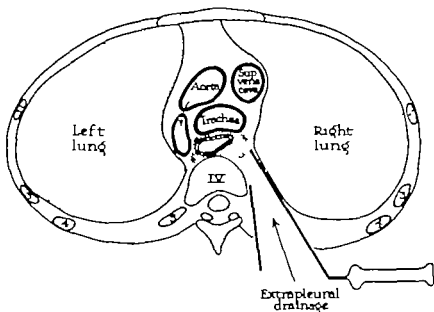


Fig. 5. Cross section at level of fourth dorsal vertebra showing extrapleural route to mediastinum.

MEDIASTINITIS

Acute infection arising from perforation of the esophagus may follow the trauma of a foreign body or result directly from instrumentation. The characteristically virulent and fatal course is well known and in fact is one of the chief hazards of any procedure that involves the surgical manipulation of this organ. The division into two stages of the relatively simple operation for pharyngo-esophageal diverticulum is a surgical expedient designed to obviate infection.

Pearse has described a method for the immediate handling of perforations of the cervical esophagus that appears sound if the accident is recognized within a few hours. Frequently however perforation by an instrument is not recognized until mediastinal infection has already taken place, or indeed the peri-esophageal infection may find origin in an abrasion of the wall of the esophagus without actual perforation. If the infection remains localized, drainage through the esophagoscope may be adequate, but the diffuse mediastinal infections almost invariably prove fatal. In 2 such cases I have employed for the purpose of drainage a direct posterior approach to the mediastinum. As one patient

recovered it seems worth while to describe this procedure. It is quite possible that a cervical drainage route could have been established with an equal degree of success but in the absence of signs of infection in the neck I feel that the posterior approach directly to the mediastinum gives more effective drainage.

CASE 2. M.B. a school teacher aged 60 years, was subjected to esophagoscopy on February 18, 1932 for dysphagia. A spur was found on the anterior surface of the sixth and seventh cervical vertebrae pushing the esophageal wall forward and causing partial stenosis. Orthopedic treatment for her spine was carried out but the dysphagia persisted.

On June 11, 1932 another esophagoscopy was performed and during the course of the examination spontaneous emphysema developed extending upward from the neck to the eyes. The patient's temperature that evening was 103 degrees and she complained bitterly of pain in the chest. The following day she began to raise foul, thin, purulent material and although the emphysema was less marked her temperature remained elevated. In the period between June 14 and 20 the raising of foul, thin, purulent material continued and she was kept in the Trendelenburg position and given repeated injections of intravenous glucose.

On June 20 another esophagoscopy showed definite perforation of the wall of the esophagus with pus draining into it. The patient's general condition was still alarming with a high fever, rapid pulse and increasing weakness. X-ray examination

showed widening of the mediastinum and haziness of the lung fields. There was no tenderness or other sign of infection in the cervical region.

On June 29 under avertin anesthesia an incision was made close to the spine over the upper portion of the chest and the lower portion of the trapezius and rhomboids were severed. The third, fourth, and fifth ribs were resected from the transverse process of the vertebrae to their angles and the transverse processes shortened. By blunt dissection the thickened and inflamed parietal pleura was separated from the lateral aspect of the vertebrae and the dissection carried forward until the lateral aspect of the posterior mediastinum was exposed (Fig. 3). An aspirating needle was inserted into the mediastinum and foul air with a small amount of pus obtained. Continued aspiration during the withdrawal of the needle yielded a free flow of blood showing that the needle had passed through the azygos vein into the mediastinum. About 2 centimeters cephalad to this point there was an area of the mediastinum that fluctuated with respiration (Fig. 4). An aspiration here immediately entered the mediastinum. A window approximately $1\frac{1}{2}$ centimeters in diameter was made at this point and foul necrotic slough with blood-stained pus obtained. The exploring finger entered between the esophagus and the vertebral column. A very soft rubber tube was sutured to the walls of the opening into the mediastinum but was not inserted into the abscess cavity for fear of further erosion of the esophagus. The incision was packed open with gauze. The patient ran a febrile course for 21 days then her temperature became normal and she was discharged from the hospital on the forty-fourth day. A small sinus persisted for some weeks but ultimately closed and the subsequent course of the convalescence has been uneventful.

CASE 3. E.C. an American woman aged 51 years, entered the Eye and Ear Infirmary on March 3, 1933 complaining of difficulty in swallowing of 2 weeks duration. Esophagoscopy was performed and an annular obstruction found 15 inches from the upper teeth. A small amount of blood was encountered and no specimen was removed. Following the esophagoscopy the patient complained of constant substernal pain. There was also marked pain on swallowing. Subcutaneous emphysema was observed in the soft tissues of the neck and upper mediastinum by X-ray. Her temperature ranged from 102 to 103 degrees with a rapidly increasing pulse and a discharge of foul pus by mouth. There was no sign of infection in the cervical region and as the patient's condition was rapidly becoming more desperate the operation described above was performed on March 17. Pus was encountered above the level of the azygos vein and an opening approximately 1 inch in diameter was made into the mediastinum. Thus foul pus and air were removed by suction and two large pieces of necrotic sloughing tissue picked out. The patient's condition rapidly became worse and she died 12 hours following the operation.

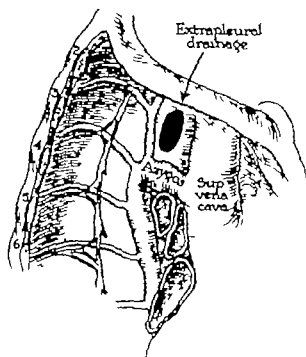


Fig. 4. Diagram showing site for entering mediastinum just above the arch of the azygos vein.

An autopsy revealed perforation of the esophagus, phlegmonous esophagitis with ulceration of the mucosa, gangrenous mediastinitis, bilateral bronchopneumonia and a carcinoma of the stomach.

CARDIOSPASM

Although the usual case of cardiospasm may be treated successfully by dilatation, need for more radical measures will be encountered from time to time. The development of surgical methods to meet these circumstances has been reviewed by Professor Bull of Oslo and by Mr. George Grey Turner (9), now of London, so my remarks will be limited to the reporting of 2 personal cases.

CASE 4. A.B., a housewife of 44 years was first examined in the Eye and Ear Infirmary on April 30, 1930. At that time she gave a history of cardiospasm dating back to a fall 11 years previously. At this time a therapeutic abortion was performed followed 11 months later by hysterectomy. A year after the hysterectomy the patient noticed her first difficulty in swallowing, associated frequently with convulsions. She described the food as almost reaching the stomach and then being held up and forming a distressing lump for which relief was found only in regurgitation or by its passing spontaneously into the stomach. She had been able to swallow only liquids and semisolids. Some solid food was 'washed' by the obstruction with the aid of water. She had at times vomited food that was 3 days old and had a foul odor. Three years before admission a period

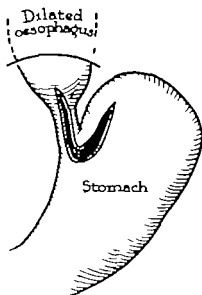


Fig. 5 Incision for oesophagogastric anastomosis

of complete inability to swallow food was relieved by a gastrostomy. This was utilized for a 6 months period and then allowed to close. Her weight during the 8 years previous to admission fell from 150 to 90 pounds.

At the Eye and Ear Infirmary a Mosher bag was passed twice with some improvement. Fluoroscopy showed dilatation of the oesophagus with retention of barium. She was treated by repeated dilatations over a period of 6 months. In June, 1931 she reported a further loss of 22 pounds. Later in August she reported that she was eating only liquid foods.

In October 1931 oesophagoscopy showed filling of the oesophagus just above the cardia but no evidence of ulceration or malignant disease. On November 16 1931 a gastrostomy was performed, the patient weighing only 91 pounds at this time. A high caloric vitamin-rich diet was given through the gastrostomy tube and she was discharged to continue this régime under the guidance of her own physician. She was readmitted to the hospital January 21, 1932 having gained over 7 pounds in the interval. Fluoroscopic examination showed a fluid level in the oesophagus at the level of the arch of the aorta. The barium meal revealed a dilated oesophagus with the usual tapering lower end and complete retention of the barium in the oesophagus.

On January 25 1932 following a crushing of the left phrenic nerve, an incision was made from the costophrenic angle to below the umbilicus. The gastrostomy incision was walled off by sterile drapings and not disturbed. Because of the narrow costal arch the ninth and tenth ribs were sectioned subperiosteally through a second incision in the mammary line. This gave an ample exposure al-

lowing mobilization of the left lobe of the liver (2). The oesophagus was freed from the hiatus of the diaphragm and pulled down until its dilated portion was exposed. It was then united to the stomach and a U-shaped incision was made with one limb extending to the dilated portion of the oesophagus and the other extending along the cardiac end of the stomach (Fig. 5). On opening the oesophagus there was no evidence of ulceration or peri-oesophageal inflammatory tissue but there seemed to be some thickening and fibrosis in the muscular layer of the oesophagus. The anastomosis was completed as in a Finney pyloroplasty and the line of suture enforced with omentum. Following the operation the patient was fed through a gastrostomy tube and her convalescence was uneventful.

On February 15, 1932 she enjoyed a meal of eggs potato and toast by mouth and was discharged from the hospital on a 6 meal bland diet.

In October 1933 she was eating everything by mouth except very heavy meats and doing all of her housework. The gastrostomy had been closed for some time. Fluoroscopy showed some delay at the cardia but a steady stream of barium entered the stomach. The patient had gained weight and was greatly pleased by the improvement following operation.

CASE 5 F.P. an American housewife aged 35 years was seen in April, 1932 complaining of substernal discomfort and epigastric pain of 8 months duration. There was no real dysphagia at the outset but regurgitation of liquids occurred when they were rapidly ingested. A month after the first symptoms, attacks of severe epigastric pain appeared, which were relieved by food or soda. These had increased in frequency and showed but slight improvement from dietary treatment. X-ray examination 3 months before admission showed a slightly dilated oesophagus with retention of barium.

Oesophagoscopy on May 5 1932 showed slight thickening in the wall of the oesophagus near the cardia. The mucous membrane was intact. There was no evidence of ulceration and a definite diagnosis was impossible, although carcinoma was seriously considered. The patient was placed on a 4 meal bland diet but continued to lose weight and suffered from regurgitation. Tincture of belladonna and nitroglycerin medication gave some relief but a second X-ray examination in September 1932 showed the same type of deformity in the oesophagus.

The patient was admitted to the hospital a second time in October 1932 the epigastric pain being less frequent but the regurgitation worse. She was kept on the wards for over a month gained weight, but still complained of regurgitation and difficulty in swallowing. Treatment with the Hurst bougies was instituted while in the hospital and she was discharged under supervision to continue bougienage. Her general condition remained stationary but the continued pain which occurred particularly after passing the bougie led to its discontinuation because of the possibility of traumatizing an ulcer. X-ray

examination in October 1933, showed a constriction of the lower end of the esophagus with marked retention and increasing dilatation.

The woman was again admitted to the hospital on October 19, 1933, and placed on a high caloric, high vitamin diet. She was able to take 8 ounces of liquid food every 2 hours so gastrostomy was not performed. Because of the severe pain accompanying the use of the bougie in this patient, it was decided to do a gastro-esophageal cardioplasty.

On November 22, 1933 the phrenic nerve was crushed in the neck and the left lobe of the liver mobilized through a right rectus incision. The lower end of the esophagus was mobilized to expose the beginning of the dilated area. No peri-esophageal inflammation, edema or scarring was disclosed. The lower end of the esophagus was sutured to the stomach with silk and the opening into the mediastinum closed to prevent contamination. A U shaped incision was then made with one limb extending out of the cardiac end of the stomach and the other running up the esophagus to the dilated area. Anastomosis was completed as in a Finney pyloroplasty and the left lobe of the liver re-suspended. Her ability to swallow improved immediately after the operation and although postoperative X rays showed the same dilatation of the esophagus, the barium passed the cardia somewhat quicker. In her subsequent course the patient maintained the improvement although occasionally regurgitation occurs, particularly at times of mental strain.

Dr. Chester Jones who has followed the patient as medical consultant, considers her status 1 year after the operation to show 75 per cent improvement. Present X ray films show very little delay in the passage of barium from the esophagus into the stomach.

We may conclude therefore, on the basis of these 2 cases and from the more extensive experience of others, that surgical measures find a definite even if limited, use in the direct treatment of cardiospasm.

SUMMARY

Illustrative cases from a limited experience in the surgery of the esophagus are presented with comments.

The history of a case of impassable lye stricture is reviewed with special reference to the handling of the chemical injury to the stomach.

Posterior extrapleural drainage is advocated for mediastinal abscess following perforation of the esophagus and a successful case noted.

Intractable cases of cardiospasm may be relieved by esophagogastric anastomosis as illustrated by 2 case records.

BIBLIOGRAPHY

1. BULL, PETER N. So-called idiopathic dilatation of the esophagus. *Ann. Surg.* 1925 81: 50 and 470.
2. LAMBERT, ADRIAN V. S. Treatment of diffuse dilatation of esophagus by operation. *Surg. Gynec. & Obst.* 1914, 18: 1.
3. OTTOW, HENRY B. Lateral transthyroid pharyngotomy. Trotter's operation for malignant conditions of the laryngopharynx. *Arch. Otolaryngol.* 1930, 12: 330.
4. PEARSE, H. E. Operation for perforations of cervical esophagus. *Surg. Gynec. & Obst.* 1933 56: 192.
5. ROVETTO, THOMAS. The technique of my method of antithoracic esophagoplasty. *Surg. Gynec. & Obst.* 1936 43: 781.
6. SAUERBRUCH, FERDINAND. *Die Chirurgie der Brustorgane*. 2d ed., v. 2. Berlin: Julius Springer 1925.
7. THEOTTER, W. Operations for malignant disease of the oral and laryngeal parts of the pharynx. *Burghard's System of Surgery* 1914, 2: 248.
8. TURNER, GEORGE G. Excision of the thoracic esophagus with construction of a gastro-thoracic gullet. *New England J. Med.* 1934, 210: 947.
9. Idem. Some experiences in the surgery of the esophagus—The Henry Jacob Bigelow Lecture. *New England J. Med.* 1931: 305-657.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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FEBRUARY 15 1935

THE 1934 CLINICAL CONGRESS IN BOSTON

THAT American surgeons are seriously interested in improving their minds and exchanging with their colleagues knowledge they have found valuable in the management of surgical relief was evidenced to a superlative degree during our most recent clinical meeting. Through the combined efforts of the central and local committees on arrangements every possible clinical facility in greater Boston was made available to the visiting fellows. A wide variety of general and special work was demonstrated. Many extra features absorbed the unexpectedly large attendance in such an interesting manner that it is difficult to believe that any visitor failed to carry away some helpful suggestion. There was a spirit of willingness and co-operation demonstrated among the teachers in our medical schools and hospitals that would be hard to equal. That the meeting was a success is evidenced by the general feeling among the visiting Fellows and by the numerous expressions of their gratitude. Those who participated in the program were

enthusiastic regarding the high grade of intelligence the eager and attentive attitude of those who filled the amphitheatres in every hospital and in nearly every clinic or demonstration. Their feeling was one of general satisfaction that their efforts were appreciated.

The scientific sessions were attended to the capacity of the auditorium. Subjects of general interest were presented by authorities from this country and abroad in a manner that held these audiences until late in the evening. Conspicuous among these speakers were the younger full time professors of surgery from our American medical schools. Some of our distinguished foreign guests participated in these programs in a most charming and effective manner. New and important advances in surgery were presented and discussed without doubt carrying far reaching benefit throughout our nation.

Boston was honored by the central committee in that the outstanding researches of Prof. Harris P. Mosher of Harvard Medical School were recognized by an afternoon symposium on "Diseases of the Esophagus." Usually local authorities are not permitted to present their work at the scientific sessions.

In addition to the operative and dry clinics in the larger hospitals of Boston which are always crowded the splendid suburban hospitals were well attended. To these more distant clinics transportation was provided by the hospital, and if the session occupied the entire day luncheon was served. That these efforts were of great value and appreciated, there can be no doubt.

The special hospital conferences were of interest as usual, and the attendance was

large. Other special conferences, on cancer, fractures, industrial medicine and traumatic surgery, were well attended. These special features of the work of the College are obviously of such importance that a continuation of such activities is necessary.

The clinics of the eye, ear, nose and throat sections were all overcrowded. Their scientific sessions were held in a special auditorium admirably suited to their needs. Many distinguished guests participated in their program all to the advantage of those Fellows interested in these specialties.

The community health meeting on Wednesday evening at the Arena was a revelation to greater Boston. There was considerable doubt in the minds of the local committee whether this great auditorium would be filled. The program was of such character however, as to attract a capacity audience. More than 10,000 of our citizens were sufficiently interested in their health to attend. Actually some 2,000 who sought admission were unable to find seats. That this will be of widespread benefit in our community is certain. Enthusiastic reports continue to come in.

The motion picture exhibitions were excellent. Many new films of approved surgical procedures were included this year. One found a continuous stream of visiting Fellows slipping in and out of this projection room. This graphic method of teaching standard methods for specific problems in surgery is of utmost value.

An attempt was made to display a limited number of scientific exhibits. These were mainly by local contributors. The only space

available was the gallery of the Statler Hotel ballroom. In spite of the inaccessibility of this arrangement it was found that many were interested and spent much time in this department.

A new feature sponsored by Dr. Shields Warren was the demonstration of fresh pathological specimens from the operative clinics each day. These were brought together and discussed by our eminent pathologists. The specimens were shown on the screen by means of the Zeiss episcope, and were of natural color and without distortion. It was possible for one to see in this manner the specimen he had seen removed that morning in the operative clinics.

At the Boston Medical Library much interest was exhibited in the historical pageant sponsored by Dr. Spector and given by the students of Tufts Medical School. Dr. F. B. Lund gave a charming and interesting illustrated lecture on the surgery of ancient Greece. Here also were exhibited the artistic hobbies of the Boston profession. Many of the Fellows enjoyed this pleasing feature.

The Presidential Meeting on Monday evening and the Convocation on Friday evening at Symphony Hall were impressive as usual. The addresses of Dr. Haggard and Dr. Greenough, the Murphy Oration by Dr. Balfour and the Fellowship Address by Dr. Lotus D. Coffman were all thoroughly enjoyed. The high grade of the candidates accepted was gratifying. It is felt that Boston may be proud to have acted as host during a Clinical Congress so obviously successful.

ARTHUR W. ALLEN

PRESIDENTIAL MEETING, CONVOCATION

ADDRESS OF WELCOME¹

ARTHUR W. ALLEN, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

ON behalf of the local Committee on Arrangements, it is my pleasant privilege to bid you welcome. It is particularly fitting that this Twenty fourth Annual Meeting should be held here as your President-elect Dr. Robert B. Greenough, so admirably typifies Boston surgery. His untiring efforts in the advancement of education and service to humanity make it assured that your institution will thrive under his leadership. Boston has always stood for a high standard of education. This has been true in medicine and surgery and community service. Our predecessors have made great contributions to science. Among them are the Warrens, Oliver, Wendell Holmes, Bigelow, Cabot, Richardson, Fitz Minter, Homans, Cheever and the Porters. Some of these have left sons, but all have left disciples to carry on the torch of learning, teaching, and service to mankind.

It has been six years since the Clinical Congress of the American College of Surgeons visited our city. During this interval there has been a considerable increase in our clinical facilities. New hospital buildings have been erected and modern equipment installed. The standard of service has kept pace with these improvements. It seems fitting to mention particularly the excellent hospitals and high grade of work now found in our

suburban communities. We wish it were possible for each of you to visit these splendid clinics and many of you will have this opportunity.

The medical schools and hospitals of greater Boston have seriously attempted to utilize every available facility to make your stay with us worth while. We realize that all of you will not be able to gain admission to each feature of the program that you may select. Let us urge you to accept with good grace some alternative clinic or demonstration for an effort has been made by the combined local and central committees to offer you nothing that will fail to be of interest. At the medical library there will be an opportunity to see interesting features pertaining to the history of our science. Also here will be displayed works of art as an illustration of a pleasing hobby by members of our local profession. Numerous other entertaining and instructive possibilities have been made available.

To those of you who are honoring us by your first visit, let us remind you of the many points of historic interest in and about this old City of Boston. You may become lost in the maze of our crooked streets but you will find our citizens courteous and helpful. It is our earnest desire that your stay with us be pleasant, interesting and beneficial.

Presented before the Clinical Congress of the American College of Surgeons, Boston, October 1-10, 1914.

THE BACKGROUND OF THE AMERICAN SURGEON¹

WILLIAM D HAGGARD M.D. F.A.C.S. D.C.L., NASHVILLE, TENNESSEE

In their life and doctrine, they (our forbears) set forth a true and lively word to the great enlightenment of our darkness — OSLEER.

SURGERY has a noble heritage. Its disciples are the intellectual descendants of all the great minds who have glorified time. There has been an apostolic succession in surgery from the Father of Medicine to each Bishop in our Priesthood to the latest devotee who enters the sacred portals. Galen, Avicenna, de Chauliac, Paré, Harvey, and Wiseman who was a bridge of one plank from the seventeenth century to Cheselden, down to the immortal Lister who gave 'a new Heaven to medicine and a new Earth to surgery.' His carbolic dressings due to Pasteur were more potent than the sweet smelling spices that Rebecca poured upon the wounds of Ivanhoe.

The background and tradition of the surgeons of the New World are predominantly British. Before the arrogant George III lost the American colonies, the best medical men in the new country were graduates of the University of Edinburgh.

Scotland's darling seat. There surgery was in full bloom. Munro I, II, and III and their colleagues flourished. The Bells were great ornaments. In London there were Parry, Cullen, Abernethy, the five custodians of the Gold Headed Cane, and the immortal Jenner, friend of John Hunter and godfather to his son. When 'the Great Surgeon' was spoken of in the days of Macaulay, the people thought of Brodie, as when they said 'the Duke it meant Wellington. There were also in that great constellation, Colles, Fergusson, Erichsen, to whom Lister was house surgeon, Simpson, and Paget. Some of these reached the empyrean, and to use Shelley's words, 'robed in dazzling immortality, sit on thrones.'

John Hunter, next to Hippocrates in the opinion of Gross, was the greatest figure in the history of medicine and the most remarkable observer of nature since Aristotle. Hunter, that lordly soul, raised surgery from the cruder and simpler procedures to the dignity and responsibility of a true science. He created a unity between physiology and pathology and linked them with the natural sciences. A brilliant number of ambitious American medical students brought back Hunter's methods and those of the great contemporary teachers and from them has developed the flowering splendor of the surgery of America, that country apostrophized by Tennyson as the—

Gigantic daughter of the West,
We drink to thee across the flood.
For art not thou of English blood?

American civil polity and supremacy among the powers is the marvel of mankind. What is denominated Americanism is the same spirit which finally subdued imperial Rome after 500 years, which stopped the hordes at Poitiers rolled back the tide of Asiatic invasion beyond the Pyrenees, and preserved civilization from oriental degradation. Americanism incarnate gave the idealism for right against might in the World War and preserved by blood and treasure the allied nations.

In the earlier days our civilization 'was nursed by strong men with empires in their brains.' The first American surgeon of whom we hear was the sterling John Jones, who with Hunter studied under Percival Pott fought in the Colonial and French wars was the first teacher of surgery in King's College in 1767 and the first in America to perform lithotomy.

William Shippen Jr. of Philadelphia, physician-general to Washington's armies, special pupil of William Hunter, was professor of surgery in the University of Pennsylvania which he helped found in 1765. Shippen with Jones of New York and Warren of Boston—the triumvirate of early pioneer surgeons living in the three large cities—disseminated their teachings throughout the 13 states.

The fertile soil of America has produced patriots, poets, scholars, and inventors but none has contributed more for human weal and happiness than the surgeon. In the first quarter of the eighteenth century, a writer in the *Edinburgh Review* asked "What does the world yet owe to American physicians and surgeons? Suppose that question were asked now. What would history answer?"

A brief epitome of the historical drama of American surgical achievements, like a trans-continental airplane looks upon the high peaks only among many great mountains. Peer reverently with me into some of the treasures of biography.

The Warren dynasty of 5 generations gave to Boston historic and epochal events in the march of American surgery. John Warren founded the Harvard Medical School in 1782.

He built beyond mortal thought—
Far in the Unapparent.

¹Address of the Retiring President, presented before the Clinical Congress of the American College of Surgeons, Boston, October 23-30, 1934.

When the Charlestown ferry to Cambridge was stopped by ice he went round by Roxbury performed his own dissections and lectured 3 hours. While Napoleon was divorcing Josephine, the Harvard Medical School was divorced from Cambridge. John Warren's older brother Dr Joseph Warren, was killed at Bunker Hill. Warren later crowned that acropolis with sublimity at the time Monroe was enunciating his doctrine.

John Collins Warren studied with Sir Astley Cooper. Cooper was trained by Henry Cline, who tapped the enormous hydrocele of Gibbon and withdrew 6 quarts of fluid. Warren was a dresser at Guy's Hospital for which privilege he paid two hundred and fifty dollars a year. John Keats was also a pupil at Guy's with American students in 1817. He abandoned medicine and in a year his imperishable "Endymion" shot through the heavens like a meteor. After graduating at Edinburgh, Warren lived in Paris with Napoleon's surgeon, Du Bois. He, with James Jackson, established the great Massachusetts General Hospital 113 years ago. There was destined to be enacted the great drama of anesthesia "the death of pain." It was joyfull news out of the new found world. The eighty-eighth anniversary of Ether Day will be celebrated tomorrow because a Warren dared to employ ether while William T. G. Morton hopefully administered it. Warren risked his unrivaled reputation, to save nothing of the life of his patient in this most sublime experiment. He was a great teacher—the surgical autocrat of New England—and dominated the Hunterian era. The first operation in America for strangulated hernia, Warren did. He introduced staphyloorrhaphy. He did amputations and cauter operations with great celerity. Longfellow his patient, said that he had the eye of an eagle and a woman's hand.

Ether anesthesia, however, was first intentionally produced for the abolition of pain in a surgical operation by Crawford W. Long, of Jefferson, Georgia. "a spot in the wilderness of a new continent," in 1842. Long used ether in childbirth delivered his wife under ether and performed one or more operations under its influence annually thereafter. Unfortunately he did not publish his work until 1849.

Philip Syng Physick has been called the Father of American surgery and had a chair of surgery apart from anatomy created for him in the University of Pennsylvania, in 1805. Through the influence of Hunter he received his house-surgery coney at St. George's hospital. "Physick was almost as much a mouthpiece of the doctrines of

John Hunter in America as was Abernethy in London. Both had many disciples but neither left a great successor. Physick paced the alleyways of Philadelphia for several years before he earned enough to powder his cue. Stephen Girard was his intimate friend and Benjamin Rush his closest associate. Physick was the first to do lateral anastomosis by compression of the two loops of the intestine by artificial anus following strangulated hernia the principle in Mikulicz's operation as done today. He also removed a thousand calculi from the bladder of Chief Justice John Marshall. He invented the tonsillotome. He wrote not at all. His students were his publishers. Physick first employed the absorbable ligature. He was the first to use the stomach pump for poison, the first to operate for imperforate anus. Physick lived in terror lest his body be dissected, whereas John Warren made a legacy in his will that his body should be dissected and his skeleton hung in the lecture room. Gross believed that Physick raised American surgery from its somewhat low state and so developed it that it soon became equal to the best surgery of Europe. Physick ignored the report of the first ovariectomy by the lion-hearted McDowell in 1809 but he was not ignored by the Goddess who emblazoned his name on the Roster of Immortals.

Nathan Smith a frontiersman in surgery performed an ovariectomy in Vermont in 1821 without the knowledge of McDowell's operation. He removed a 10 pound tumor and dropped the pedicle after tying it with a leather ligature. He founded Dartmouth Medical School in 1808, established the medical department of Yale College, New Haven, and filled the chair of surgery in 1813. Welch said of him that he did more for the general advancement of medical and surgical practice than any of his predecessors or contemporaries in this country.

"Premier surgeon of the West," Benjamin W. Dudley of Lexington Kentucky after graduation at the University of Pennsylvania, studied abroad. The money for his European education was obtained by taking a flat boat of produce to New Orleans, exchanging it for flour transporting it to Lisbon, where he sold it for enough for a 4 years course in London and Paris. He did 225 lithotomies with 222 recoveries. He was the first to ligate the subclavian artery for an aneurism, (larger than a quart pitcher), in 1825. His success was largely due to the use of boiled water and the boiling of his instruments. In 1818 he challenged Daniel Drake the great man of the West, to a duel which was declined, and his friend, Dr Richardson who took it up was shot in the groin

but saved by the skill of Dudley who quickly ligated the femoral artery. He and Drake became fast friends and colleagues in Transylvania University, the first medical school west of the Alleghenies. Drake inaugurated most good and great things in Cincinnati, but that did not prevent Dudley from essaying to make a rent in the robe of *Æsculapius*.

Valentine Mott, also a pupil of Astley Cooper, was the most famous of the New York surgeons. His contemporaries even regarded him as heroic. In 1813, he excised the clavicle completely for osteosarcoma. It was the day before Waterloo when her beauty and her chivalry had gathered in Belgian's capital. Mott tied the primitive carotid 51 times and the femoral 57 times. The first ligation of the innominate artery he did in 1818. In 1826, he reported the first successful ligation of the common iliac artery. In all he performed 138 ligations. He lectured for 56 years continuously.

George McClellan founded Jefferson Medical College in 1825 and invented teaching by public clinics. He wore a swallow tail coat and made his daily visits in a chaise. It was the year when Lafayette made his last triumphal tour to the United States. The son of George McClellan commanded mighty armies and stood upon the flaming brow of Malvern Hill. Brilliant, bold confident operator he was the first to excise the parotid gland.

J. Marion Sims, a South Carolinian, born near the native heath of Andrew Jackson, did his memorable work in the cure of vesicovaginal fistula at Montgomery, Alabama, and made lacerated women whole. What prodigious effort, what abounding faith! He had operated upon the slave, Anarcha, twenty nine times with twenty nine partial or complete failures when, on that May day in 1849, he used the silver wire suture for the first time. It was an entire and complete success. Sims established The Woman's Hospital in the state of New York in 1855 which was the fountainhead of gynecology. He was succeeded by T. Addis Emmet, master gynecologist. Sims demonstrated his operation before Nélaton, Denonvillier, and Velpeau. While living in Paris, he attended the Empress Eugénie at St. Cloud and was physician to the Duchesse of Hamilton. He operated in many of the capitals of Europe. A heroic statue of Sims stands facing the New York Academy of Medicine.

The lure of the Napoleonic era took many American students to Paris. In the second third of the nineteenth century, it had supplanted Edinburgh as the popular mecca. The French

took the torch. Laennec and Trousseau occupied the teaching forum and had the world as an audience. France was the crucible of civilization. Science, art, and surgery vied with literature, drama, and vice.

Henry I. Bowditch studied under the great Louis. While Trousseau had suggested thoracotomy, Wyman designed and employed the trocar and cannula and the technique in 1850 with Bowditch, who is said to have aspirated the chest after that some three hundred times without a fatality. The celebrated Dupuytren died of empyema rather than submit to aspiration, saying that he had never known anything to succeed.

Henry J. Bigelow was one of the most brilliant of the products of the French school. A revered teacher, beginning in 1849 in Harvard, he discovered the iliofemoral (Y) ligament of the hip joint. His greatest contribution was in lithotomy by the perfection of the lithotrite. Stones crushed and removed by the evacuator at one sitting was a procedure perfected by him in 1878.

Samuel D. Gross was the most conspicuous surgeon of his day between the era of the French and German ascendancy. He was denominated 'the master of American surgery', born in 1805 the year of Austerlitz and Trafalgar. Gross was an office student of George McClellan. He excised the trifacial nerve, invented the urethrotome, and perfected the treatment of stab wounds. His monumental treatise on surgery was begun while he was professor in Louisville. It was the first great American authority. When he spoke, 50 years of American surgery was speaking through his lips and he has been referred to superlatively as having earned the royal title of the emperor of American surgery.

The remarkable times in which the pioneers lived emboldened them to perform operations that had never been done before. Abdominal section of the extra uterine pregnancy was done by a bold surgeon in New York, John Bard, in 1759. It was not until 1804 that Lawson Tate did the first operation of the sort in England. William Baynham, of Virginia, performed the operation for extra uterine pregnancy twice with success in 1799 in Essex County.

Dr. Jesse Bennett, in Virginia, did a caesarean section on his own wife in 1794. Cogswell was the first to ligate the primitive carotid successfully for primary hæmorrhage, in 1803. Walter Brashear of Bardstown, Kentucky, did the first successful amputation of the hip joint, in 1806. Deaderick of Tennessee removed a large part of the lower jaw, in 1810. Francis Fontaine Maury, a native of Kentucky, performed the first operation of gas-

trotomy in this country. Kinloch, a Charlestonian, General Lee's staff surgeon, was the first to open the abdomen in case of gunshot wounds where there was no protrusion and sutured the perforations. William T. Bull has the distinction of first successfully opening the abdomen and suturing the perforations of a gunshot wound in 1885.

The first nephrectomy appears to have been performed by Winkott in Milwaukee in 1861. 8 years before Simon performed the first case in Germany.

Dr. John S. Bobbs, of Indianapolis, did the first operation on the gall bladder from which a number of gall stones were removed. The patient recovered and was taken to the Portland meeting of the American Medical Association in 1902 where some of you may have seen her as did the speaker. The first splenectomy was done by Dorsey in Piqua, Ohio, in about 1855.

The first hysterectomy for a fibroid tumor of the uterus was performed by Walter Burnham of Lowell, in 1853.

Hunter McGuire, one of the most distinguished teachers of surgeons in the South, was Stonewall Jackson's surgeon. He was the first to tie the aorta after Sir Astley Cooper (1868).

New Orleans furnished a brilliant group. To Warren Stone is ascribed the first resection of the rib for drainage in empyema and abscess of the liver. T. G. Richardson was the first surgeon to do a bilateral amputation of the hip joint at the same sitting in 1843.

Smith was the first to cure an aneurism by ligation of the innominate artery in 1864. Mott's first case in 1818 was unsuccessful. Miles and Parham flourished and were succeeded by the surgical scholar and seer of America, the full-orbed star of the Crescent City.

Louisville produced Vandell, the scholarly and Matthews, the courtly surgeon. McMurtry was the chevalier and apostle of the new abdominal surgery.

Nashville was graced by Eve, surgeon in four wars, who taught surgery to 454 students in 1859, the largest medical class ever gathered together outside of Philadelphia, and Briggs, also a lithotomist, both presidents of the American Medical Association. Haggard, who with W. E. B. Davis of Birmingham founded the Southern Surgical Association in 1888 and the brilliant Douglas.

In California Henry Gibbons gave the first course of medical lectures on the Pacific Coast in 1850, and his first patient was said to have dropped an ounce of gold dust on his desk (value of \$16) as his fee. The other great pioneer sur-

geons of San Francisco were Gibbons, Cooper, Toland, Lane and Goodfellow, who was the exponent of the earliest prostatectomy.

The Northwest found the elder Mayo laying the foundation of the greatest surgical development yet witnessed not only in America but in the entire surgical world.

About 1860 the begira to Germany by American students began. Virchow, Traube, and Langenbeck were the tripod upon which pathology, medicine, and surgery rested. Langenbeck was the most dexterous surgeon of his day. It was said that a man who came to see him do an amputation, paused to take a pinch of snuff and when he had sneezed the operation was over. Efficiency and great devotion were inspired by the masters—Kocher, Trendelenburg, von Bergmann, Billroth and Mikulicz.

Keen was the first to bring back antisepsis to Philadelphia after his German tutelage. With his friend, the gifted S. Weir Mitchell, he made studies abroad on gunshot wounds and nerve suture. He was one of the first teachers of pathological anatomy. His pen was as mighty as his scalpel. He was the Nestor of surgery in our time. Joseph Pancoast, to whom was referred the daughter of the Lord Chancellor of England by Sir William Fergusson as the greatest plastic surgeon in the world, antedated him. We see also in Philadelphia the flashing scalpel of Agnew, whose clinic is immortalized in one of the strongest paintings of modern times.

In Canada, surgery had an almost exclusive English background and produced such stalwarts as Shepherd, Armstrong, Starr and the great universities at Montreal and Toronto.

In New York in the latter half of the nineteenth century were Van Buren, Buck, James R. Wood, Frank Hamilton, T. Gaillard Thomas, Sand, preceded by Willard Parker, who did much to familiarize the profession in 1861 with the wisdom of operating for appendiceal abscess. The metropolis has had in the last four decades a long list of surgeons of stellar brilliance—of these McCosh, Abbe, Gerster, Wyeth, Bryant, Dennis, Stimson, Weir Bull, and Peck have luster.

Charles McBurney and Reginald Fitz did their transcendent work in appendicitis. McBurney perfecting its operative treatment in 1889, after Fitz described its pathology a year before. They both passed into the Valhalla of surgeons in the same year—1913.

Philadelphia, the cradle of surgery, had, as its pride, the Ashursts, White, Rodman, the matchless Deaver and Da Costa—scholar, author, teacher—who said, "No one knows of the ham-

ing anxiety, the deep disappointments, the baffling perplexities, the dread responsibilities, and the numerous self reproaches of one who spends his life as an operating surgeon. His hand must be as light as a floating perfume, his eyes quick as a flashing sunbeam, his heart as broad as humanity, his soul as sweet as the waters of Lebanon."

Baltimore was first seen in the firmament by the light of William Gibson who was a pupil of Sir Charles Bell and a friend of Byron, and who was wounded at Waterloo. He was the first to perform the operation of ligating the common iliac artery in the year of our last war with England. Baltimore's fame was enriched by William S. Halsted, founder of the Hopkins School of Surgery who did great work in conduction anesthesia, carcinoma of the breast, goiter, hernia, and many other fields touched by his genius, which is never to be forgotten. This luminous figure having no children of his own, was the prolific Father of Surgeons.

Among Boston's great are remembered Cheever, Homans, Cabot, the Porters, Mixter, Munro and the great hearted Maurice Richardson who taught the newer abdominal surgery, and, as Mumford said of Oliver Wendell Holmes, sat for years amid the Esculapians in the seat of honor.

In Cincinnati there was Connor, Dandridge and Ransohoff, in the twin cities Wheaton, Moore, and McLaren. When we think of Albany we think of Van der Veer, of Buffalo of Roswell Park, of San Francisco, Harry Sherman and Tom Huntington, of Richmond George Ben Johnson, of St. Louis, McDowell, Pope, Hodgen—who devised the ingenious and useful suspension splint of Texas, Thompson, and of the Pacific North west, the late lamented Coffey, who devised safe ureteral transplantation.

The radiant sun of modern surgery that was to shine so effulgently over Chicago had its dawning with the arrival of Daniel Brainard in shabby clothes on an Indian pony. He found not more than one hundred people around Fort Dearborn. In 1837, he took out a charter for the Rush Medical College and after a season of study in Europe opened the College in 1843. Brainard's work was original on ununited fracture, the invention of the bone drill, and iodine injection for spina bifida.

Moses Gunn, a luminary, was succeeded by Charles T. Parks, physically and mentally a gem. Edmund Andrews was the first to employ nitrous oxide in general surgery. The group that made Chicago famous as the clinical center of the West comprised Fenger, Senn, Murphy, and Ochsner.

Fenger brought the new pathology to America. Senn waited table for his board while practicing in Milwaukee and made the experiments in intestinal anastomosis in his basement, but at the International Congress in Moscow he was acclaimed the Premier Surgeon of the World when he presented his paper on "Pentonitis" and was carried on the shoulders of his ardent admirers.

Murphy—greatest of American surgical teachers—cured ankylosis, introduced therapeutic compression of the lungs and invented the most exquisite surgical device in the world—the Murphy button.

Ochsner, chief of staff of Parks and Senn, became one of the greatest surgeons in our time and had the largest individual private surgical clinic in America. His voluminous writings covered many subjects and covered them well.

These are some of the great surgeons of the Western World. Many wore the splendid robes of fame many 'the muses decked with gifts of grace.

This rich background is your precious professional heritage. Hold it to your heart and cherish it.

Not Mars his sword nor war's quick fire shall burn
The living record of their memory

The pride we have is not chauvinistic. We hail the improvements of our art from any clime. Far from being self satisfied in the plenitude of our science it is the principle of our guild to acclaim any real contribution to science whatever its country in the effort to prevent disease and mitigate its blight. Surgery has made such vast conquests that we cease to wonder. Its beneficent factions make the angels rejoice.

Shall we be content?

Descartes said that if there is any possible way of increasing the wisdom and ability of mankind it must be sought in medicine.

What shall be said for that great multitude of American surgeons who did not teach or write?

What of those who never sang,
But die with all their music in them?

They have lived to lessen the sorrows and assuage the anguish of mankind for the surgeon is a gleam of sunshine in the patient's dungeon when the loved ones are wrapped in black despair.

What a rich inheritance to be a surgeon in America my America!

In the land of youth and freedom beyond the ocean bars
Where the air is full of sunshine, and the flag is full of stars.

EFFICIENT SURGICAL SERVICE FOR THE WHOLE COMMUNITY?

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UNDER the broad charter of its articles of incorporation, the American College of Surgeons has brought about outstanding improvements in the practice of surgery in this country in the 22 years of its existence. It has set up qualifications for Fellowship of such a nature that the public may have confidence that every Fellow of the College is in fact worthy and competent to practice his designated branch of the art of surgery. The results accomplished by the College in its standardization of hospitals are world-renowned and the work of its committees on fractures, cancer, sarcoma, and traumatic surgery has contributed greatly to the improvement of the quality of surgical service supplied to the community.

Within the past few years, however, it has become increasingly apparent that competent medical and surgical service is not everywhere to be obtained by all classes of the population.

Depression and unemployment have been responsible for the more general appreciation of these facts, and have indeed been to a considerable extent the cause of them, but few will deny that the provision for efficient medical and surgical service including preventive medicine, has not for some time past been sufficient to meet the needs of all classes of the community. As Fellows of the American College of Surgeons, these facts deserve our serious consideration.

In the 20 years which have elapsed since the beginning of the great war profound changes have been taking place throughout the world, which have so altered the habits and thoughts of people of all nationalities as to produce almost a new civilization. During this period the advances of science have been unprecedented, and the application of these advances to the daily life of the people, whether in the form of new inventions to enhance their comfort and happiness or as additions to the resources of medical and surgical science for the protection of their health, has contributed greatly to the welfare of mankind. This has been a period of mechanical and technological ascendancy and of quantity production. In the widespread development of new methods of production and distribution of the essentials of existence, it is not surprising that the older methods of supplying medical and surgical service should have been criticized as ineffective. As a matter of fact, medical practice has not remained alto-

gether immune to these new influences, and the development of specialization in medicine and surgery is an example of the modifications which the scientific advances of this period have made necessary as the sum of medical knowledge has increased. It is as a result of these developments that the group method of practice has come into existence.

As a rule, however, the medical profession has resisted attempts to extend mass production principles to the practice of medicine. It is their belief that the peculiarly personal and fiduciary nature of the relation between patient and physician is too precious a relationship and one of too much value to the community to be jeopardized by radical changes of a socialistic nature. This attitude on the part of the profession is one to be commended rather than condemned. The individual member of the community is dependent upon his medical advisor for the maintenance of his health and functional efficiency. In the opportunity to select the physician or the hospital in which he has confidence rests the first step in that relationship of trust which plays so great a part in the satisfactory conduct of medical practice. The physician has been trained to accept the grave responsibilities that are involved in this fiduciary relationship and the Hippocratic oath is evidence sufficient that this important feature of medical practice has been recognized both by the public and by the profession since before the Christian era. This peculiar responsibility of the physician is further safeguarded by the code of ethics which is universally accepted by the medical profession. This code of ethics is designed primarily to protect the patient and the community by the elimination of those physicians who are unworthy or unwilling to accept the altruistic principles upon which the satisfactory conduct of the practice of medicine must inevitably rest.

Living conditions in this country however have been profoundly altered in the past 5 years. Depression and unemployment have reduced many individuals from a position of relative independence to one of indigence, and have brought those who were once in easier circumstances down in the scale of living below the comfort level. At the same time the reduction of the incomes of the well-to-do has been such that sums they formerly contributed to charitable purposes

have been greatly reduced in amount, and in some cases have been abandoned altogether.

Under these circumstances, it is not surprising that town, county, state, and finally even federal authorities have been obliged to assume increased obligations in order to provide even food and lodging for the destitute. The resources of the towns and counties have proved in many localities to be insufficient and the former scanty provisions for the medical care of the indigent have become even less adequate than they were before. The extra burden has fallen chiefly upon the physicians and surgeons of the community to supply medical and surgical service to the indigent sick without remuneration. To this call of humanity physicians have responded, as one of the duties and obligations of a great and honorable profession. As a result, however, many members of the medical profession have by this time themselves been brought perilously near to the level of indigence. More effective methods of supplying medical and surgical service to the community, and especially to the indigent and to the lower income groups of the population, and of providing suitable remuneration for those who give this service is an immediate and urgent necessity. Not only is this necessary to maintain the health of the community itself but it is needed also to preserve the medical man-power of the country. The amount of time and money involved in the education and training of the physicians and surgeons of the United States represents an enormous investment of time of money and of effort and one which if destroyed could not possibly be replaced for a period of many years. What has been said in regard to the medical and surgical personnel applies with equal cogency to members of the dental profession to nurses, social workers, laboratory technicians and all of the ancillary professional groups who are concerned in supplying medical and surgical service to the population.

While the present situation is of grave importance to all of the professional groups that gain their livelihood by participation in the provision of medical and surgical service it is of special concern to the surgeons of this country. The injuries and diseases the surgeon is called upon to treat almost invariably require hospitalization and a more or less extended period of subsequent supervision. All too frequently these hospital expenses exhaust or exceed the patient's limited resources and further payment for professional service becomes impossible.

We recognize that hospitals are doing their utmost to cut their cost of operation to the lowest

possible figure. Ingenious projects for greater economy have already been instituted in hospitals all over the country. Conferences of the hospital department of the College have been devoted to this subject, and these efforts on the part of the management should be heartily supported and to a great extent guided by the members of the hospital staff. The chief and final consideration which must be recognized in this respect is the quality of service which the hospital can supply. Economies which lower the quality of this service must be avoided or the safety of the community will be seriously impaired.

From the point of view of the surgeon the quality of service given to the community is of supreme importance. Very few of the injuries or diseases with which the surgeon deals are of the self limited class or tend of themselves to spontaneous recovery. The patient who requires surgical treatment is generally one in whom some gross mechanical condition is present, which must be removed or corrected before that individual can be restored to health. A great part of the surgeon's work is also necessarily of an emergency character and deals with injuries and acute diseases and with the acute and imperative complications of more chronic disease. In all of these conditions delay is dangerous, and what is of equal and sometimes greater importance, the moment for efficient treatment is fleeting and what must be done, must be done not only promptly but correctly, or the patient's chance for recovery may be irretrievably sacrificed.

The first and most important element in the delivery of efficient surgical service then is the qualification of the surgeon for the work he has to do. With the varying state laws for licensure to practice the healing art, we are at once confronted with the fact that the qualifications of the physicians and surgeons admitted to practice in the different states are by no means uniform. Furthermore, there is only one license in a given state, and this permits the physician or surgeon to practice any form of medicine or surgery for which he may consider himself qualified. His conscience, indeed, is his only guide. This is true even of the licentiates of the National Board of Medical Examiners who are admitted to practice in a number of different states without further examination.

Every graduate of a recognized medical school and every physician who holds a license to practice medicine in the different states of the Union has been taught the general principles of surgery. In general practice and especially in districts remote from the great centers of population, the

physician must be prepared to give surgical as well as medical service, especially in emergencies, for he is frequently the only possible source of aid at such a time. The American College of Surgeons now carries eleven thousand surgeons on its rolls as Fellows of the College, but it would be manifestly impossible for all the surgical service needed by the community to be given by these qualified surgeons alone. For emergency service and for minor surgical procedures the community must not infrequently be dependent upon the general practitioner. Let it be said at once that the efficiency with which such service is supplied, day in, day out, all over the country by physicians in general practice is deserving of the highest praise and the widest recognition.

For major surgical service however prolonged training, more intense application to this restricted field, adequate laboratory and hospital equipment, and the judgment and dexterity obtained only from experience, are qualifications which the physician in general practice cannot readily obtain. The more specialized surgical service of the community must therefore be provided by those who have established their ability and fitness to give this service, and these qualifications Fellowship in the American College of Surgeons is designed to certify.

When we reflect, however, that in spite of the lack of any legal restraint, the medical profession has been so effectively controlled by its principles of ethics as to prevent the abuse of public confidence by the individual practitioner attempting to do surgical work beyond his capabilities, we must acknowledge again a high degree of moral sense and altruism as having been established as a tradition of the medical profession.

The American College of Surgeons represents the only existing organization designed to establish definite and distinct qualifications for the practice of surgery. Similar organizations exist for the qualification of specialists in some of the other branches of medicine but the field is by no means covered by these independent agencies.

The amalgamation of all of the different boards for the certification of specialists under some co-ordinating influence is at present under consideration and would undoubtedly lead to a more satisfactory appreciation by the public as well as by the medical profession, of the value of such qualification. It would be unreasonable and unwise, however, for the individual State Boards of Registration to attempt each to set up its own standards for the licensing of physicians and surgeons in the different specialties. Certification of specialists should be national in scope, reasonably

uniform in its requirements, with due regard to the varying demands of each form of special service and above all things, should demand a broad general medical and surgical training as a foundation upon which specialization may be firmly based.

Since no single national organization exists at the present moment for the certification of physicians and surgeons as to their qualifications for practice of all of the different special lines of medical activity we must seek some other means of classification if we desire to deliver the most effective service to the community. Such a means is available to us in the hospitals. All but the smallest hospitals maintain such a division of their staffs, varying from the primary separation into surgical, medical and obstetrical divisions up to the divisions of the larger hospitals into separate services and clinics in 25 or 20 different specialties of medical and surgical practice. Physicians and surgeons in hospitals are further classified into permanent staffs and courtesy or associate staffs, but no hospital worthy of the name fails to exercise control and supervision over the work of its staff to give serious consideration to the qualifications of candidates for its staff appointments, or to withhold appointment from those who are not professionally qualified or are otherwise unworthy.

The classification of specialists which is provided by the hospitals, may well be utilized in any plans for providing more efficient service to the community. Since the hospitals themselves are an essential part of any such project, they may prove to be the most satisfactory units with which to construct these plans, and in any case their co-operation and participation will always be an absolute necessity.

It is not necessary however that such plans should be restricted to hospitals which have been approved by the American College of Surgeons. The advantages of such approval are today so obvious to the trustees, staffs, and patients of every institution, and to the public as well, that no small part of the benefit which has accrued to the community from the hospital standardization movement is the notable improvement of conditions in all hospitals, including particularly those which have not yet succeeded in reaching the minimum standard of the College but which are steadfastly approaching that goal of their ambition.

From early colonial times up to the present day it has been an accepted principle in this country that the maintenance of the destitute and their medical and surgical care are an obligation upon

the community. This obligation has been discharged more or less completely by means of private charity through endowments, or by local taxation. Only recently, and we must hope temporarily, because of the inability of these resources to meet the increasing demands occasioned by unemployment and depression has it been necessary to call upon the state and federal governments for financial support of these activities.

The official machinery of the community by which these responsibilities have been met has varied from the appointment of a city physician in the smaller communities to the establishment of Welfare Departments, overseers of the poor, and city and county almshouses and hospitals with medical officers on a full time salaried basis or giving only part time service with or without remuneration. In addition to these services for the indigent, organized public health departments have been established in cities and towns, as well as by the state to supply the needs of the community as a whole in the way of health administration, sanitation, the preparation of vital statistics, and quarantine measures in the communicable diseases. In many states however a considerably broader program has been developed by public health departments, involving health education, demonstration clinics, research in public health problems, the provision of biological products for therapeutic purposes, and similar measures. The maintenance of institutions for the care of the insane and of the tuberculous, although not as a rule directly under the supervision of the Department of Public Health represents another important and necessary medical activity of the local or state government.

The development of the public health services has been a gradual one and from its very beginnings it has been supported and guided by the medical profession. Of late years, however, there has been a disposition on the part of the profession to be critical of some, at least, of the more recent expansions in the field of public health, on the ground that the state was thereby entering into direct competition with the practicing physician. Where the practicing physician is properly equipped to give efficient service, such competition must be condemned and medical or surgical service by the state should be restricted to the indigent. Where such is not the case, however, no one is better aware than are the members of the medical profession that more efficient service made available by means of the financial resources of the state is to the material advantage of themselves and of their patients, and they are quick to avail themselves of these resources.

Neither physician nor layman will maintain that the public should be deprived of the opportunity for efficient service, when such service cannot be rendered by the practicing physician, except with the aid of those departments of the government which are concerned in the maintenance of the public health.

The problem of providing efficient medical and surgical service to the whole community is at the present moment seriously complicated by the deplorable ignorance of large groups of the population in regard to what efficient medical service really implies. The enormous sums expended annually for patent medicines and for the services of the quacks and cultists show that in many cases it is ignorance rather than economic conditions which lead people to such deplorable waste of their resources and of the opportunity to regain their health at the same time.

It must be clear to every one that it would be a waste of effort to make efficient medical and surgical service available to the whole community, unless or until the individual members of the community are sufficiently informed to make them ready to accept this service. At the present moment, while the demand is undoubtedly great it is by no means universal. The ignorant and the credulous represent a formidable group throughout the country, and for their own sakes, as well as for the safety of the community at large they must be educated rather than coerced to protect themselves. Today, with toxins and antitoxins, vaccines and serum tests with insulin and other hormones and vitamins all based on accurate experimentation in the laboratories and with the X ray and other physical agents at our disposal, no one who is informed can doubt that physical, chemical and biological science is the foundation upon which the edifice of modern medicine has been constructed. This knowledge of the basic facts of medical science must be more widely published, in order that people may accurately estimate the futilities of the quacks and cultists, and the follies they advocate in the way of treatment of disease. Campaigns of public education of this nature can be carried out with propriety by the great national organizations of physicians and surgeons as well as by city state and federal public health departments. The individual practitioner, who must restrict his part in public education to the instruction of his own patients, has the right to look to the larger organizations to fulfill this manifest public duty.

Just as the education of the public is a necessary feature of any project for providing more effective service to the whole community, so also is the

postgraduate instruction of the medical profession. Physicians and surgeons who are not in close proximity to the centers of medical education are of necessity limited by their continued occupation in competitive practice, by the paucity of their professional income, and by the great amount of charity service they now supply in their opportunities for postgraduate study. In a profession which advances as rapidly as does medicine, text books become out moded almost as soon as they are published. Medical journals and medical societies attempt to keep the practitioner informed of the notable discoveries of importance in medicine, but the practical estimate of the comparative value of these new developments is more difficult for him to obtain.

Of late years steps have been taken by a number of state medical societies to make available postgraduate instruction in medical and surgical subjects by bringing instruction to the physician instead of obliging him to leave his practice to go to some medical center to obtain it. Such plans are meeting a long felt want and give good promise of raising the general standard of medical and surgical efficiency but the needs for postgraduate instruction of the medical profession throughout the country are as yet but inadequately supplied.

From the point of view of their ability to pay for medical and surgical service, there are at least three classes of the community to be considered namely (1) the indigent, who cannot pay at all (2) those of adequate means who can afford to pay for what they need and (3) the intermediate group or those of moderate means who can pay for minor medical service but cannot unaided finance the expenses of serious illness or prolonged hospitalization within their restricted incomes.

The care of the indigent sick has long been recognized as an obligation upon the community and one which either through official sources or by private charity has, to a certain extent at least, been satisfied. So far as hospitalization and nursing care are concerned this is frequently the case, but all too often physicians and surgeons have been expected and permitted to contribute their services gratuitously for the care of this portion of the population.

The physician who serves the community should not be expected to stand in any different relation from that of other professional men who qualify for the public service. Except in teaching hospitals, where some equivalent other than financial return accrues to the physician or surgeon, in the way of reputation or opportunity his services should be paid for as are the services of lawyers,

engineers and other professional men who serve the city or the state.

Many communities already provide hospitals for the indigent sick maintained by public funds. When, owing to unusual circumstances such as those which exist today, the demand exceeds the accommodation available, such cases can very properly be accommodated in other institutions or in their own homes, and their care be paid for by the community on a cost basis and with a fee schedule for professional services on a minimum but reasonable scale.

Such a plan has already been authorized by the Federal Government for the medical care of dependents in the F. E. R. A. and the C. W. A. in their homes or in the doctor's office. While the many forms and records with which the government finds it necessary to protect itself are unfamiliar and annoying to the physician, an important principle has been established that the government recognizes its obligation to remunerate the physician who serves the community by taking care of the indigent, even though such remuneration is at present on a scale which must be regarded as a minimum.

The medical and surgical care of the well-to-do is reasonably well organized at the present time and no great modification of private practice as at present conducted, need be contemplated. It is undoubtedly true that very considerable expenses could be saved in caring for the well-to-do if they and their physicians and surgeons were disposed to eliminate some of the expensive laboratory tests, X-ray examinations and consultations which are so frequently demanded when their necessity is not apparent in the uncomplicated case. Such extravagances can only be avoided with difficulty if the patient is anxious to have them and pay for them but the physician is aware of the fact that the money thus expended would often provide needed hospital care for many patients in the lower income class.

The most difficult problem which presents itself in the organization of medical and surgical service to supply the needs of the whole community is presented by the great mass of the population which falls in the moderate means group. Individuals in this class can be independent and can select and pay for such medical service as they may need only so long as serious illness requiring prolonged hospitalization and continued medical or surgical care is not encountered. When serious illness does come, the middle class patient must either assume obligations in the way of debts which he can seldom discharge or he must lose his independence and become a burden on the

community. It is to this class especially that it has been proposed to apply the prepayment insurance principle in order to spread the expenses of serious illness over a period of small monthly payments for a number of years. It is a fact that health insurance in one or another form has been adopted as the most promising solution of the difficulties of this class of the population in some 40 countries in the world in the past 30 years.

Health insurance may be either voluntary or compulsory. In almost every other country the attempt has been made to start with a voluntary plan and it has been found necessary later to resort to compulsory insurance required by national legislation. This is not surprising when we consider the lack of knowledge of health matters, and the common characteristics of improvidence and lack of concern for the future which so frequently govern the actions of the human race. Some of these national insurance plans, as in Russia, involve the complete socialization and regimentation of medicine, a condition which is abhorrent to our western civilization. This is the form of medical practice which as 'State Medicine,' with its inevitable political control and destruction of individual initiative is regarded by physicians as a menace to the best interests of the medical profession and of the community as well. Other plans, such as the British National Health Insurance Act, involve changes which are far less revolutionary and permit the medical profession to retain control of the medical aspects of the problem and to this extent at least, are looked upon with less disfavor by physicians who have made themselves familiar with the details of these different projects.

In a country composed of so many diverse elements as those which make up the United States of America with the population here crowded in great industrial centers, there scattered in agricultural districts and in other places more widely distributed still over the practically unsettled and frontier districts of the north and of the west, it is not to be expected that any single national plan for providing medical or surgical service to the whole community should prove everywhere to be satisfactory. The problem is essentially a local one to be studied and solved by the members of the individual communities and by trial and error if by no other means. In these experiments it is of vital importance that the medical profession should take the lead.

Already the Workmen's Compensation Laws of the several states require industry to apply the insurance principle to the medical and surgical

care as well as to the compensation of the injured workman, and the insurance principle seems to be in fact about the only way in which people in the moderate means class can be expected to pay either the hospital or the physician for the necessary costs of serious illness or operation. The machinery for the operation of the Workmen's Compensation Law is maintained by the state. In many states an insurance fund, operated by the state but contributed by industry, is provided as an alternative to commercial or mutual insurance. We must all believe that the principle of workmen's compensation for industrial injury and disease has come to stay. In many communities in this country experiments in the way of providing medical and surgical care on a prepayment insurance basis have already been attempted, and the results of their operation are being studied with the greatest interest. Most of the prepayment plans which have been put in operation have been started by industrial groups and involve a restricted territory and one of relatively uniform population. They vary from single group clinics to county medical society organizations. State wide projects of this character although proposed have not yet been put in operation. In order to escape the dangers of unfair competition, a plan should include all of the medical and surgical agencies of the local community that are qualified and willing to co-operate in giving such service. If too large the diversity of population and employment on the one hand and of medical resources on the other, may endanger the satisfactory operation of any plan. The American College of Surgeons has taken the position that prepayment plans of this nature should be "free from the intervention of commercial organizations operating for profit, in order that the maximum amount of the fund may be available for the payment of the medical, surgical and hospital expense which is to be supplied. Prepayment insurance plans not infrequently have been opposed by the medical profession on the ground that their operation in one way or another involves violation of the accepted code of ethics, especially in the matter of commercialism, advertising and unfair competition. That such dangers are present and must be avoided is clear to the physician or surgeon however difficult it may be for him to explain these objections to the layman. They rest in fact upon the experience of years of medical practice, and they are based upon knowledge of the weaknesses as well as of the stronger qualities of human nature.

The moderate means group which we have been discussing includes all those with incomes above

the indigent class and below the 'well-to-do.' It would not be unreasonable however to make a further subdivision of this large class of the community into at least two smaller groups—namely (1) those on the *lower level* whose resources even when they are employed, could not be expected unaided to provide, on a periodic payment basis, a sufficient amount to pay the cost of full medical and surgical service and (2) those of the *upper level* who can, through periodic payments, assure themselves of sufficient resources to obtain this service without resort to community help or public funds. The lower level group of the moderate means class are the members of the community for whom the provision of efficient service presents the greatest difficulties.

The difference between the amounts which individuals in this lower level group can pay and the actual cost of the service supplied, must be obtained from other sources. In this case as in providing for the indigent, the responsibility must devolve first upon the community. Many who now as indigents receive charity service undoubtedly belong really in this lower level group. A rigid investigation of their economic condition is necessary for their classification.

By virtue of the fact that the community is paying all of the expenses for the care of the indigent, and a proportion at least, of that of the lower level moderate means group the community itself should assume the responsibility for the quality of the service thus supplied.

The upper level group of the moderate means class may be counted upon to carry their own medical and surgical expenses provided hospital accommodation and efficient medical and surgical service can be made available to them on a basis of minimum fees. Within the past few years many hospitals have developed special intermediate wards for patients of this group where hospital expenses are reduced to a minimum by the elimination of non-essentials and a correspondingly reduced fee for professional service is collected by the hospital and paid to the physician or the surgeon in charge of the patient. Voluntary prepayment plans for hospital expenses or even for full medical and surgical service can undoubtedly be organized in connection with such services, and are greatly to be preferred to the present commercial health insurance projects which have been developed widely and have received such severe criticism in a number of states in the past few years. It is of great importance, however, that prepayment plans of this nature be not restricted to individual hospitals or smaller groups. They should be a *co-operative community organization*,

in order that all unfair competition may be avoided.

Great difficulty will be found in defining accurately in dollars and cents the limits of these different economic classes. Standards undoubtedly will vary from one community to another. Whatever criteria may be established in a given community in regard to this classification on an economic basis its observance should be rigid. One of the grave criticisms of the administration of our charity hospitals today is based upon the fact that the actual need for charity medical service is not always established beyond dispute in every case admitted to its wards. While the extent of this abuse undoubtedly varies considerably in different communities, those who seek undeserved free medical service at the expense of the truly destitute, must be meticulously sought out and prevented from obtaining such advantages. On the same basis the enjoyment of moderate means accommodations and reduced fees in hospitals should be rigidly restricted to those of limited resources whose finances do not permit them to obtain needed care in private practice.

The Medical Service Board of the American College of Surgeons has laid emphasis upon the necessity for strict observance of the code of medical ethics in the conduct of these new and experimental methods of supplying service to the community. In the consideration and evaluation of their success the medical profession must unavoidably be guided by the extent to which the new plans permit adherence to this code. Wide latitude is given however within these limits for the trial of such new methods of practice as may be suited to individual communities. The co-operation of the medical profession is essential to their successful operation and should be as freely given in this emergency as are their services on every other occasion where their need is manifest.

The co-operation of other groups than the physicians is also to be desired in consideration of these plans. Data of great importance have already been collected upon this general subject. The vast majority of the medical profession has hitherto paid but scant attention to great national social and economic problems. From the sociologists and economists much important information is to be obtained and a closer and more harmonious co-operation between these groups and the medical profession appears to be the great need of the present moment, in order that each may contribute of its knowledge to the solution of perhaps the most important question which affects the physical welfare of the community in the present generation.

In the Hospital Department of the American College of Surgeons we possess already an organization which is functioning in a most satisfactory manner for the survey of the hospitals by trained investigators. Through this department of the College accurate data in regard to such local prepayment or insurance plans as are now in operation or may be developed in the future can be readily obtained. It would seem at the present moment that the information we need upon which to base judgment as to their value can thus be secured at less expense than in any other way. It would be advisable, therefore to continue the collection of this information in order that it may be made available to those who are studying these problems.

The responsibility of industry for maintaining adequate emergency medical and surgical service for its sick and injured employees is at present widely recognized. The Board on Industrial and Traumatic Surgery of the American College of Surgeons has contributed in no small degree to improving the quality of this service by the establishment of minimum standards for industrial surgical services, based upon the fact that proper qualifications over and above those necessary for a state license to practice medicine, must be required of those engaging in this special form of surgery. The field of industrial medicine and surgery includes not only a consideration of the requirements of the Workmen's Compensation Laws of the several states, but as well a more extended program of medical and surgical supervision of the health of employees by physical examination, by study of the work hazards and requirements of the special industry by health education, and by the practice of preventive medicine.

Smaller industries and, in certain parts of the country, even those of larger size, have frequently chosen to entrust the risks and expenses of industrial accidents and workmen's compensation requirements to commercial insurance companies or 'carriers' organized to assume these obligations. It is not unreasonable of course to expect that the responsibility of the insurance company, under these conditions, should become precisely that of the original employer so far as goes the obligation to supply adequate and qualified surgical service in the emergency treatment of the industrial accident case, and that in its subsequent supervision it should ensure that competent surgical care is given. The fact that either the employer himself or the insurance company which has accepted the responsibility for him is paying the expenses of such treatment and has a corre-

sponding interest in the successful outcome of the case, with a minimum of loss of time and a maximum of ultimate functional efficiency, justifies their insistence upon the adequate qualifications of the surgeons who give this special form of service. For the moment, the most practical way to secure these qualifications is to encourage those hospitals and those surgeons who desire to do this form of surgical work to meet the minimum standard established by the Board of Industrial and Traumatic Surgery of the American College of Surgeons.

With this necessarily brief review of some of the many different and somewhat conflicting factors which appear to demand consideration in any concerted movement to supply more efficient surgical service to the various economic classes of the population, we may well conclude that further information must be obtained by carefully organized and critically studied experiments before it will be possible for a final program of action to be prepared.

No single health insurance plan of national scope appears at present to be applicable to the conditions existing in this country. The matter is at present one for local study and experiment. In such a study the best medical and surgical ability in the community is needed, acting in co-operation with others qualified by their knowledge of economic conditions to join in the solution of the problem.

The provision of adequate service for individuals of the lower level income classes in the moderate means group, is the most difficult part of the problem. Some support derived from the community, to supplement any possible prepayment insurance plan, may possibly be needed to meet the requirements of individuals in this class. With further progress in health education those in the upper level of the moderate means class may well develop an interest and a desire to participate in voluntary prepayment plans, beginning perhaps first with hospitalization alone, and extending ultimately to full medical, dental and nursing services.

It is greatly to be desired that the trial of these new methods of providing medical and surgical service should be encouraged in different communities where the co-operation of the hospitals, the medical profession and others interested in the maintenance of the public health can be secured. Certain general principles which should be observed in the organization and operation of these plans have already been approved by the College. The Hospital Department of the College provides a ready means of securing accu-

rate information in regard to these plans and their operation, which should continue to be utilized to accumulate facts on which future judgment may be based.

While the advantages and disadvantages of the different plans for health insurance are under investigation in this laboratory of experience, a number of other steps are immediately open to us which should be of material help in providing more efficient service.

- 1 The value of the code of ethics of the medical profession in the protection of the interests of the whole population must be more widely appreciated by the public.

- 2 The medical and surgical care of the indigent sick must be recognized everywhere as an obligation of the community.

- 3 The segregation of hospital wards for patients of moderate means, who can and should

pay minimum hospital expenses and reduced fees, should be more widely practiced.

- 4 Abuses of hospital charity by those who can afford to pay must be prevented.

- 5 The expansion of the activities of public health departments into the clinical field should be restricted to demonstration clinics for educational purposes and to such other activities as can be made available to the community only by the use of public funds.

- 6 The education of the public in regard to health matters, and the postgraduate instruction of physicians should be more widely developed.

- 7 The quality of service supplied to the community should be recognized both by the public and by the medical profession as the first and most important consideration in every plan for providing more efficient surgical service and making it available to all classes of the population.

CANCER CLINICS AND CANCER SERVICES IN GENERAL HOSPITALS¹

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FOUR years ago the Board of Regents of the American College of Surgeons announced its approval of plans for the development of special cancer clinics and cancer services in general hospitals. This action was not taken by the Board of Regents without due consideration of the presumed advantages as well as of the possible disadvantages of such a segregation of cancer patients from the general medical and surgical services of hospitals. Time has not yet elapsed sufficient for final judgment as to the value of these special clinics, but it would seem to be appropriate at this time to review some of the opinions which have been expressed in regard to the advantages and disadvantages which may result from their organization, and to consider to what extent their operation during the past 4 years has justified this recommendation of the College.

The report of the Committee on the Treatment of Malignant Diseases which was accepted by the Board of Regents and published in October, 1930, emphasized the fact that cancer institutes in which both clinical service and research were carried on simultaneously required such large endowments for their support as to prevent their establishment in any considerable number of centers throughout the country. It was recognized, however, that such institutes formed the most effective method of providing treatment for cancer patients who could obtain their services.

Special cancer hospitals, with adequate charitable endowment or supported by the state, were acknowledged to be the next most effective method of providing cancer service. Such hospitals may be expected to provide diagnostic and therapeutic facilities of nearly as high a grade as that of the cancer institute. They lack, however the generous endowment or other support required for the maintenance of laboratories and of the full time research staff qualified in the several different branches of science which are required to carry on effective cancer research.

The American College of Surgeons is concerned especially with the quality of service which can be supplied to patients with cancer and its recommendations were designed to improve this service. The vital necessity, however, for the continued laboratory investigation of cancer is acknowledged by surgeons as well as by all other physicians who have to deal with this disease.

The support of cancer research therefore both by persons of wealth who may be able to devote endowments or contributions to this most important field of investigation, and by the use of public funds, should be urged by every member of the medical profession as one of the most necessary fields for medical investigation. On account of the expense of construction and maintenance of cancer institutes and special cancer hospitals the fact must be accepted that a sufficient number of such institutions cannot at present be provided to take care of any considerable proportion of the cancer patients in the country.

Special cancer clinics and cancer services in general hospitals were next considered and because of the small expense involved in their maintenance and the fact that their organization permitted the same group method of approach to the individual cancer patient which has been the essential feature of the service given by the cancer institutes and special cancer hospitals the development of such special clinics in general hospitals was strongly advocated. As a matter of fact, two forms of cancer clinics in hospitals were recognized: (1) the fully equipped treatment clinic and (2) diagnostic clinics without complete treatment facilities. Both forms of clinics however employ the group method of study of cases. It was hoped that diagnostic clinics would be inspired to obtain the necessary professional experience and the material equipment to develop into treatment clinics, and be enabled thereby to give full service. In some instances this development has occurred, and if it were not for the difficulty in securing sufficient funds for the necessary equipment under these conditions of depression, such developments would probably have been possible in many other cases.

The Minimum Standard for Cancer Clinics in General Hospitals which was established by the American College of Surgeons includes six paragraphs dealing respectively with the details of organization, conferences, patients equipment, records and treatment. The details of these requirements need not be repeated here. They can be secured by anyone who is interested from the office of the College and are already familiar to many who are present.

The situation may be briefly summarized, however, as an attempt on the part of the College to

¹ Presidential Address, presented before the Convocation of the American College of Surgeons, Boston, October 26, 1934.

procure more efficient care for the cancer patient by establishing the following general principle: The patient's interests are best served when the representatives of the several branches of medical science concerned in the study and treatment of cancer work together in a co-operative manner, instead of arrogating each to himself a limited field in which his own influence is paramount. That such a condition of individualism was almost universal a short time ago is abundantly proved by the publication in medical literature of many articles dealing with the treatment of cancer by writers who displayed so prejudiced a view in favor of their own special methods as to indicate conclusively their ignorance of the accomplishments of other branches of science in this extensive field. In this narrow attitude the surgeons have been perhaps the chief offenders, but intolerance of the views of others is by no means confined to surgeons; it is a common human failing, but in this instance it may be overcome by the group method of co-operative study and discussion designed to provide for the cancer patient the most effective treatment which contemporaneous medical knowledge will permit.

The advantages to be secured by the establishment of cancer clinics in general hospitals may be listed as follows:

1. The patient receives more complete study and more efficient treatment.

2. More accurate and complete records are secured for subsequent analysis of end results with a view to the increase of knowledge. The use of the standard abstract record forms of the College assures more accurate recording of data, and a uniform system of classification for cancer in all of its more important situations.

3. The follow up of cancer cases after treatment is more systematic and contributes to the welfare of the patient as well as to the accumulation of more accurate knowledge.

4. Concentration of the cancer material of the hospital in the hands of a group provides greater experience for the individual members of the group and aids the development of their proficiency and productivity with resulting benefit to the patient, to the hospital and to the community.

5. The conference meetings of the clinic staff provide opportunity for more adequate undergraduate and postgraduate instruction in the subject of cancer and its treatment, and the reference of patients to the clinic by physicians in private practice permits the extension of this educational influence widely throughout the community.

6. The special cancer clinic provides a convenient and inexpensive method for supplying expert consultation service to aid the general practitioner and his patients in securing the diagnosis of cancer in its early curable stage.

7. Without material extra expense, and by mere rearrangement of services in the hospital in such a way as to entrust the cancer work to those who are more interested in this subject than in other special branches of surgical activity and are qualified to assume these responsibilities, opportunity for more efficient service to the patient is secured.

In order to estimate the extent to which cancer clinics in general hospitals have demonstrated their hoped-for advantages in the brief period since they have been in operation we must consider these seven items one by one.

1. The first item to be discussed and the one which is, and always will be, the most important, is the question as to whether the cancer patient does in fact obtain better treatment in the cancer clinic than under the old regimen. It would be indeed surprising if the opportunity provided for more careful study of the cancer patient by the group did not result in more accurate diagnosis of the actual stage of the disease. Cancer in its many situations presents a number of different paths of dissemination and frequently different sites of predilection for metastases can be recognized. Some of these peculiarities are characteristic of the histological type of tumor under consideration, and others are determined more by its anatomical situation. Thus the more experienced study of the group often discloses remote metastases which are positive contra indications to the attempt at radical cure of the disease by surgery and the patient is thereby protected from unnecessary operative measures which would be doomed to failure in any case.

The close association of the surgeon and of the radiotherapist in the cancer clinic permits them also to co-operate in providing more efficient palliative treatment in the advanced cancer case. The combination of radiation therapy and of surgical measures can frequently be effectively employed to bring about relief of distressing symptoms, and even to accomplish temporary arrest of the malignant process, with the result that the patient may live for a long period of relative comfort and even die *with* but not *of* cancer as a result of some intercurrent disease.

The early diagnosis of cancer is promoted, first, by the greater diagnostic experience of the special staff and, second, by reason of the possibility of exploratory operations, which can be performed

with safety in many instances only under restricted conditions, with competent frozen section diagnosis available and with the immediate completion of such radical operative or radiation treatment as may be indicated in the individual case.

Finally, only by consultation, such as is obtained between the surgeon, the radiotherapist and the pathologist in the clinic, can a wise decision be made in the many cases of cancer in which the choice between surgery and radiation treatment, or a combination of the two, is dependent not upon any general rule, but rather upon the conditions existing in the individual case.

Such considerations as have been mentioned are, however, still somewhat theoretical and the real test as to whether the cancer patient obtains more efficient care must be determined by the attitude of patients and of their medical advisers toward the services of the clinics. Everywhere the attendance at cancer clinics is on the increase. In some hospitals in which the reference of patients within the hospital is voluntary and not obligatory, the attendance at the cancer clinic has been steadily increasing year by year. There were 14 cancer clinics in the country in 1920 and they were chiefly in cancer institutes. In October 1933, there were 158 approved by the College, and some 155 in course of organization or awaiting survey. Such a development must indicate that the belief is widely held that through the organization of a cancer clinic, the patient obtains more efficient treatment.

2. That the establishment of cancer clinics leads to the making of more accurate and complete records of cancer cases can hardly be denied. No one who has looked up hospital records of 10 years ago with the object of studying a group of cancer cases, but has discovered many individual records so lacking in the data now considered essential in the way of history, physical examination, pathology, and details of treatment as to be of no value whatever for classification or analysis. With the interest of the special group composing the clinic staff in preserving accurate and complete records, and with the aid of the standard abstract record forms prepared by the College the records of cases in the cancer clinics have been greatly improved. The element of uniformity alone obtained by the use of the standard abstract forms is a material advantage since a uniform method of recording and of classifying cases permits the collection of data on a much wider scale than heretofore, by the assembly of records from many different clinics, and makes possible a

justifiable comparison of the end results of different forms of treatment which we have not had before.

3. Twenty five years ago no hospitals anywhere had a systematic follow up system of all their patients and in only a few institutions in this country—and usually then only at the instigation of some interested member of the staff—was any effort made to maintain a continuous investigation of the long time end results of the treatment of cancer. Dr E. A. Codman's crusade for the more general adoption of end result studies in hospitals is well remembered by the older generation of surgeons today, and has borne fruit in the widespread development of follow up clinics in general hospitals all over the country. In spite of the gradual adoption of these principles, however, the long time continuous follow up of cancer patients has not even yet been universally adopted or vigorously carried on in general hospitals. Such a follow up, however, is an essential feature of cancer clinic service. The advantages of such a continued interest are readily appreciated by the patient. Appointments for follow up visits are seldom broken, and only rarely is it necessary to call upon the social service department for home visits and further investigation. The present knowledge of the end results of the treatment of cancer on a minimum 5 year basis has already made possible the collection by the College of an enormous number of 5 year cures of cancer, a movement which has done much to dispel the pessimism of the public as well as that of the medical profession in regard to the possibilities of the successful treatment of this disease.

4. The concentration of the cancer material of the hospital in the care of a relatively small group gives opportunity for a much richer experience and increased opportunity to the individuals selected for the cancer clinic staff. It is not unreasonable, of course, and rather is it to be expected, that this special assignment of privileges to one group shall be compensated by similar assignments to other groups of other branches of special work, such as fractures, circulatory disease or similar subjects of special surgical interest, as a *quid pro quo*. Such assignments may be only temporary and a certain amount of rotation of privileges of this sort is often advisable in the case of junior members of the staff.

The surgeon who receives an assignment to a special clinic, whether it be by the direction of the chief surgeon of the hospital or by the decision of an executive staff committee, should accept it as a privilege, which it becomes immediately his duty to justify. Such justification must be dem-

onstrated not only by the increased efficiency of service given to the patient, but by such study and investigation of the hospital clinical material, as will add to the professional reputation of the institution.

5. The essential feature of cancer clinic organization is the group attack upon the cancer problem. The group must include primarily one or more representatives of each of the three special branches of medicine which are most intimately concerned with the study and the treatment of cancer—surgery, pathology and radiotherapy. Each of these different individuals brings to the group-study of the cancer patient special knowledge and experience which has been acquired only through a long period of study of these special lines of medical science.

Until the group study plan was inaugurated prejudices and misunderstandings extending even to bitter accusations of violation of the ethical principles of medicine were not uncommon among the representatives of these different specialties concerned with the treatment of the cancer patient. It is extraordinary to observe the readiness with which such biased judgments disappear when free expression of opinion and experience can be secured in personal conference over the problem of the individual case.

Such conferences are first and foremost of advantage to the members of the group on account of their educational effect, but this educational advantage is by no means confined to the individuals participating in the discussion. It extends immediately to the junior attendants, internes, medical students and nurses who are connected with the clinic, as well as to members of the general hospital staff and to physicians who desire to attend the conference as visitors, in order to keep in touch with progress in the diagnosis and treatment of cancer.

A further extension of the educational influence of the cancer clinic is the practice prevalent in many clinics, of encouraging the physician who refers his patient for advice to come to the clinic with the patient and share in the group discussion of the case. When this is impossible a letter is usually written to the physician who sends his patient to the clinic giving the full details of diagnosis and of the treatment advised. Such measures not only extend the educational influence of the clinic, but they also procure the co-operation of the physician in the subsequent follow up of the patient to the advantage of all concerned. In fact the educational advantages of cancer clinics are so readily appreciated as to be hardly open to discussion by anyone familiar with their operation.

A cancer clinic in a general hospital provides expert consultative service at a minimum expense to the medical profession of the community. The difficulties encountered in the diagnosis of cancer in its early and local stages are widely recognized. The general practitioner without the experience or the equipment to solve these problems is further handicapped in dealing with a doubtful case by the fact that he cannot afford to get the reputation of being an "alarmist" neither does he wish to refer his patients unnecessarily for consultations involving loss of time and travel expenses as well as heavy consultation fees. For reasons such as these, he is tempted to delay. Unfortunately this delay may be of vital significance in determining the success or failure of treatment in the individual case which actually proves to be cancer. When consultation involves merely a visit to the nearest general hospital with a minimum of expense and loss of time, this occasion for delay is done away with to the advantage of the patient and of his physician as well.

From the point of view of economy there is no doubt that the cancer clinic in the general hospital has advantages that are not to be gainsaid. It provides within the limitations of the professional ability of the staff and of the equipment of the hospital, a service patterned on that of the major cancer hospitals and institutes. This is accomplished by the simple re-assignment of the services of the hospital staff and a corresponding classification and redistribution of its patients.

In the surgical staff of every hospital there are some surgeons who are interested in one phase of surgery and others in another. Such interests are recognized by every chief surgeon in the assignments he makes of the hospital material. The establishment of a cancer clinic is but a slight extension of this plan, involving the participation of the staffs of the surgical, the pathological and the radiotherapy departments and of suitable representatives of other services, such as medicine, gynecology, genito-urinary surgery, otolaryngology and dermatology. The co-operation of the neurosurgeon, the orthopedic surgeon, and the dentist is also much to be desired. The only extra expense the hospital need consider is the provision of suitable space for examining rooms and for clerical and social service workers, and a convenient conference room. The salaries for clerical and social workers must, of course, be included. Most general hospitals are already equipped with all of the surgical instruments and apparatus required for the diagnosis and treatment of cancer and many have excellent X-ray equipment for therapy as well as for diagnosis. In some hospitals radium

in sufficient quantity is already available for treatment. Where this is not the case the greater expense of purchase of radium must be considered or the need may be met by arrangements with other institutions. When such facilities are already available in the hospital, the expense involved in the organization of a cancer clinic is thus a minor consideration.

The principal disadvantage which has been claimed to result from the organization of a cancer clinic in a general hospital, is that the segregation of the cancer cases and their removal from the general medical and surgical services diminishes the interest and the experience of physicians and surgeons on these services and tends to restrict the treatment of cancer to a limited group of specialists. This disadvantage must be admitted in regard to cancer as it is admitted also in regard to orthopedic surgery, genito-urinary surgery, gynecology, neurosurgery and a number of other special branches of surgery and of medicine which have developed and flourished as a result of the rapid advance of medical science and the virtual impossibility for any single human mind to acquire and retain in serviceable form the amount of knowledge which has resulted from the medical progress of the past 50 years. The day when one surgeon or one physician could make himself master of all of the information needed to deal efficiently with every variety of disease which may present itself has long since passed, and specialization is the answer to this condition. It is through specialization indeed, that many of these same advances in medicine and surgery have been brought about. Specialization is the price we of this generation are obliged to pay for the benefits we have obtained from the progress of medical science in the past 50 years. Not only must we believe that specialization has come to stay but we must recognize that its further development is imminent. Even in this special subject of cancer further limitations of the general field are already evident in the subdivisions of interest and of experience on the part of the individuals who are united in the cancer clinic staff. The special interests and the special qualifications which determine these subdivisions of the work of the cancer clinic are to the positive advantage of the patient as well as of the staff. It is a form of voluntary division of labor which yields most

desirable results. Such division of the work of the clinic may be only temporary and elastic and rarely need be extended beyond the hospital, but an established reputation along some special line inevitably brings the demand for consultation service from professional colleagues. This subdivision of the work of a cancer clinic is further an economy of time. In clinics which are open every day one day of the week may be devoted to one group of cases and the next day to another to the obvious advantage of conservation of the time and energy of the staff and the avoidance of undue delay on the part of the patient.

Another objection which has been raised against the organization of these special clinics is that the term cancer creates apprehension and sometimes despair on the part of some of the patients who may be advised to come to the clinic for consultation. This feeling is so strong in certain communities that the alternative term of "tumor clinic" has been employed as an euphemism, although the clinic carries on exactly the same functions under either name. As a matter of fact the progress of public education has already brought about a change of attitude on the part of the public toward the term cancer. The subject is discussed more freely and with far less apprehension than was the case 20 or 30 years ago and this supposed disadvantage will probably disappear entirely in a few years more. If not, the use of the term tumor clinic is an easy remedy.

In conclusion, we may say that the suggested disadvantage involved in the organization of cancer clinics in general hospitals—that it tends to make the treatment of cancer a specialty—must be admitted. It does and it does so intentionally, but it is a group specialty, not an individual one. There is abundant evidence that under the group method of study and of treatment the patient the physician in general practice, the surgeons of the country and the community itself believe that the cancer patient receives more efficient treatment. We may conclude therefore, that there is no occasion at this time to alter the policy of the American College of Surgeons of advocating the organization of cancer clinics in general hospitals. Rather should this policy be re-affirmed and efforts be made to aid these clinics in every way to provide still more efficient service to the cancer patients seeking their help in the years to come.

MEDICINE AND PUBLIC SERVICE¹

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NO progressive person would return to a simpler life with its primitive practices and superstitions if he could. With all of the complexities and difficulties arising out of a constantly expanding civilization, we should prefer to face its problems and to deal with its complexities rather than return to ignorance and superstition in dealing with the issues of life. Every civilization in the long run pays for what it does not have as truly as it pays for the things it possesses, but it pays for the things it does not have with a different kind of coin than it uses in paying for the things it does have. Ignorant and backward nations pay in poverty, destitution, unborn hopes and ambitions, ignorance and unnecessary sickness, for the scale of civilization that they maintain. Under such conditions the demagogue finds the ignorant populace an easy prey to his nefarious schemes. The practice of the various professions, such as medicine, law, the ministry, and education is necessarily on a low level under such conditions. The progressive development of the well-being of a people calls for sacrifices in effort and money. Every step forward taxes the ingenuity of the people, lays necessary tribute upon their resources, and calls for an increasingly superior quality of service.

What is true of nations in general is likewise true of groups that are responsible for the advancement of their professions. It is true of the medical group. No one would have medical practice revert to the days when we knew nothing of vitamins, of radium, of the roentgen ray and radiant energy, of the chemistry of drugs, of the use of serums, or of modern surgery. We are well aware of the fact that contributions to medical knowledge in the last sixty years have exceeded in number and significance the contributions of the preceding three or four thousand centuries, and we have only begun. What lies ahead is entirely in the lap of the gods; it depends to a very large extent on the attitude that we take towards science. This is no time to be talking about science taking a holiday. Indeed the cure of human disease, the alleviation of human suffering, the prolongation of human life—in fact, all those things which contribute in any way to physical and mental health are directly dependent on the further advancement of science. Science cannot halt nor falter in its work, it must study

every change in our social and industrial order for every change probably creates new diseases, changes certainly modify conditions affecting old ones. Practically every step forward in the march of civilization has been marked by some discovery, some invention, and by the extension and distribution of human knowledge. Mankind is engaged in a continuing process of regeneration; each regenerative step is simply another mile stone in human achievement.

The representatives of the medical profession have certain responsibilities and obligations in common with the representatives of all other professions. The two chief responsibilities that they have are namely, to advance the basic knowledge and the craft spirit of their own profession and to promote the common welfare. The advancement of the interests of one's own profession is best performed by devoting oneself to his profession. Simple as this seems to be, it is not always done. Too many lawyers, too many teachers and too many doctors worship at the shrine of their avocations rather than at the shrine of their vocations.

From observations ranging over more than forty years in the educational field I am of the opinion that the surest way for a scholar to win recognition is to become a better scholar; the surest way for a lawyer to become distinguished is to become a better lawyer; and the surest way for a doctor to achieve success is to become a better doctor. Obviously one cannot become a better scholar, a better lawyer, nor a better doctor except by devoting himself diligently and faithfully to his profession—all of which means that he must, among other things, study and master the new knowledge appearing in his field.

It is true of course that there are a number of factors that make this extremely difficult. One is the growth of knowledge itself. It is now extremely difficult, if not impossible, for one to know every thing about a given field of learning, but in so far as it is possible, surely there rests upon the professional man the obligation to be the master of the things that he professes. An other factor that makes it difficult for him to achieve this ambition is that in recent years there has been a tendency to subdivide knowledge and to differentiate and specialize practice. Partitioned practice in the field of medicine certainly



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has earned with it all of the weakness of specialism in general and has greatly increased the costs to the patient.

If I may be permitted, I shall cite one personal experience which illustrates what I mean. I realize of course, that this experience may be a little extreme and that it may not have been possible for these events to happen in any other part of America. Some years ago, when I was in another state, I was suffering from some throat trouble. I was anxious to find out what the source of the trouble was and if possible to have it remedied. I called on a certain doctor who was a member of a certain clinic and who had a long printed form consisting of some two hundred questions which I was required to answer. These questions asked for far more detailed information than I would be expected to give in case I were applying for insurance: they not only went back to my immediate ancestry, but to my grand ancestry and my great-grand ancestry. All of my habits of life were minutely inquired into. After this man had secured a complete inventory of my ancestral history, of my physical weaknesses and of my opinions on all sorts of subjects, he very wisely informed me that he would now take time to examine his report more carefully, but in the meantime he would pass me on to Dr. So-and-so, with the suggestion that this doctor examine my tonsils. Dr. So-and-so placed a long slender piece of birch board down my throat, required me to say "ah" in a half dozen different languages and finally decided that a culture should be taken of the tonsils, but that he would not have it done that day. He did pass me on to a third doctor to have my teeth roentgenographed. When this man had completed pictures of all my teeth, he said, "I never pass judgment on the pictures. I only take them." That made it necessary for me to see another doctor who decided that one of my teeth was ulcerated at the roots and that it should be extracted. Still being unsophisticated in the ways of the medical and dental professions, I went unsuspectingly to this fifth doctor who proved to have an expert assistant. This man gave me some sort of gas, and while I was under the influence of it the offending tooth was removed. Upon my returning to consciousness this doctor said to me, "That was a very difficult tooth to remove. You have a badly lacerated jaw. It will now be necessary for you to have it treated for several days by Doctor —." Then the explosion occurred. I raised the roof. When I received a bill for the services that had been so generously given me during the afternoon, it was for \$125.

I do not recite these facts to condemn the medical profession, only to show what kinds of unfortunate practice may creep in, partly because of the differentiation of knowledge and partly because of blind obeisance to the god of specialization.

Clearly there is need for the co-ordination of work among specialists in every organization. Surely one who dissects a person's lower maxillary should know enough to treat it afterwards. Medical practice cannot be standardized in the way in which industry can be, nor can operations be performed on a mass production basis, but when a doctor confines his practice to the winking muscle of the left eye he is really going too far.

While the surest way for an individual to advance himself in his profession is to become more professional, the surest way for any group of specialists in a profession to advance themselves and the interests of their profession is to co-ordinate and to organize their activities so as to insure the fullest freest, and most intelligent co-operation.

Any profession that is constantly advancing will find it necessary to raise its standards from time to time. The people of a country have a right to improved service. Not only must there be a raising of standards, but means must be provided for the continuing development of those engaged in practice.

I am not much concerned about the number of doctors that we have. I know there is a vast amount of talk among the members of your profession as to whether there is an oversupply of doctors. Figures are cited to show that we have about one physician to every 750 or 790 persons in the United States and that this is a larger number than is to be found in England, Germany, France or Sweden. It is believed that the presence of so many practitioners is in itself a weakness because it leads to unfair and unprofessional competition.

I recall another circumstance which I think has a definite bearing on this particular matter. About ten years ago I was invited to be a lay adviser of one of the great foundations of this country in connection with certain projects that it proposed to make in stimulating a public interest in personal and community health. We proposed to go into a number of communities, some urban and some rural, in various sections of the country, with a view to testing out our theories. When it was announced that we expected to go into a certain city, a city of about 40,000, every doctor in town I think, joined in a protest against our coming. We were as unwelcome as Mr. Hoover would be in Mr. Roosevelt's cabinet. No doctor

wanted us. But not fully understanding the medical mind we went into the community nevertheless. We took a group of trained nurses and competent doctors into the community. The nurses began having conferences with expectant mothers and with mothers of infants with regard to prenatal and postnatal care of children. The doctors began having meetings with small groups here and there at which health score cards and charts were devised for the school children. The nurses and doctors who represented the Foundation were persons of rare intelligence and attractive personalities; they were adroit and skillful in meeting people and in discussing matters with out offending them. At the end of the year the local medical society which was composed of all of the doctors in the community had a meeting and passed resolutions requesting the City Council to levy a tax which would be the equivalent of fifty cents on every person in the community to maintain the service which we had established. What was responsible for this change of heart and mind? The doctors said that there had been no reduction in their business during the year as a matter of fact, it had increased; their incomes had increased and, furthermore the quality of their work was much higher than it had been a year before more persons were coming to them asking for advice, seeking examinations in matters relating to their health and that of their children. The modern knowledge about diagnosis, treatment and prevention of human disease which had been dispersed by these unwelcome guests, had raised the quality of medical knowledge and of medical practice to a higher professional basis than ever and the doctors were happy.

Some five years ago while in Russia, I visited a number of clubs that had been established for laboring people. I remember one in particular where there were about one hundred men and women—peasant men and women—listening to a doctor who was talking to them about the simplest things relating to their own health and that of their children, and their responsibility for the health of the community. The vacant expressions of these peasant men and women began to light up as they began to understand a little here and there about the things the man was discussing. It was the first time in their lives that they had ever received any instruction along these lines. This campaign for the diffusion of learning bearing upon physical and moral health, has been carried on widely throughout Russia.

It is my opinion that every time we raise the cultural level of a people we increase their wants, we multiply their needs we fructify their ambi-

tions. Perhaps the medical profession should take steps to request that none except those who possess adequate ability should be permitted to enter upon the study of medicine, and that none except those with the highest ethical ideals should be permitted to engage in the practice of medicine. But one of the surest ways of solving the over supply problem in this, as well as in every other profession, is to educate the people with regard to the service the profession can render.

Then another one of the problems with which the medical profession is gravely concerned is how to distribute medical services so as to care for large numbers of people. We hear this movement referred to as a movement for socialized medicine. It manifests itself in various forms in some countries in the form of insurance. In others the government subsidizes medical practice in certain areas. In some instances individuals within a community engage a community doctor and voluntarily levy a tax upon themselves and in others, corporations, manufacturing concerns, and business enterprises of one kind or another engage doctors to care for their employees. The thing that we shrink from in America apparently is the use of the term "socialized or state medicine." It is anathema to many. When Dr. Angell of Yale spoke before this convocation, he said that we should not be disturbed by a name. He advised us to look carefully into the matter and to make our decisions on the basis of facts and the quality of service that we should undertake to render. In our antagonism to a point of view regarding a form of practice, we must not overlook the fact that the recruiting officers of state socialism are want, restlessness, and despair nor must we overlook the fact that we have many socialistic institutions and socialistic forms of control in America. The American public school system, for example, is the greatest socialistic experiment that the world has ever witnessed. Our fire departments, our police systems, our post offices, are examples of pure socialism in government.

The American people are practical people; they are constantly seeking something that works; the test of its success is the quality of work that it performs. The American people are distrustful of abstract ideas, abstract political theories, abstract social theories; they aim to take the course that works best in actual practice. For that reason there is a mixture of every form of control in America—democracy, communism, socialism, constitutionalism, autocracy, dictatorship—each in turn under differing circumstances, has been approved and has been accepted when the motives

were found to be good motives and the practical results were proved to be good results. Human life is so varied, its problems so complex and so numerous that they cannot all be forced into a strait jacket of any single theory. Just as good government will use many methods, every method depending upon the circumstances, to advance human welfare, so professional groups likewise must have a pragmatic philosophy, changing their methods when changes will produce better results.

Nor must we overlook the fact that the masses everywhere are demanding greater opportunities and a larger share of the comforts of the world. They want good government, employment, old age insurance, unemployment insurance education for their children, and the opportunity to live healthful, wholesome lives. They are trying to fashion a new philosophy in a world that is still held in check by administrative practices, modes of procedure, and outlooks of another day. The American people want to be shown that the things they desire cannot be attained. The important thing about our people is their common sense: they believe that the world is not finished, they think it is still advancing, they are willing to experiment with methods and processes and forms of organization of a humanizing and socializing character. They are not ready to accept these things wholesale, but they are willing that they shall be tried.

Wherever people under existing conditions cannot obtain the benefits of modern medicine, there is a serious gap in the distribution of this service. To this extent civilization fails. Either we sit back and acknowledge the problem as insoluble or, regardless of preconceptions or alogans, we seek a practical solution. If the solution calls for some changes in the traditional way of distributing medical services, we shall allow need and service to guide our practices rather than tradition or selfish interests.

Doctors live to serve others. The relationship between the doctor and the patient is intimate and personal. That is the real reason why we shy at systems, codes, and forms of political control. Should the politician stand between the patient and the doctor both the patient and the medical service would suffer. It requires a powerful idealism on the part of the community and great strength of character on the part of the individual to sacrifice political ambition and personal ideals for the common welfare. No people has ever done it to any considerable extent or for any long period of time and yet every people is constantly trying to achieve this goal. Sacred

covenants and promises to act collectively in the common interest, even when communities or professional groups have been operated under the inspiration of a moving religious principle, have often vanished as disillusionment has entered the souls of such communities or groups. Perhaps it is ease and material prosperity that dulls our hopes and darkens our ambitions and makes us cling to traditions. Perhaps after all there is something fine and subtle in human nature—a native inherent unspoken hope to live one's life in the manner in which he thinks he can best serve others, that lures one on to greater achievement. No one would wish to curtail idealism of this type. Great individuals, whether inside or outside an organization, will achieve to serve and serve to achieve.

It must be true indeed that the life of every organization comes at last to depend on those few who do the work and who actually put their hearts into it to maintain that solidarity of interests that is essential for the preservation of the ideals of the craft. On the other hand, I know that there is always present in every craft an inevitable minority who through indifference, lack of responsibility selfishness or a desire to live softly, refuse to meet their moral obligations or their covenants. These obstructionists will not survive, for life is being tested more and more by spiritual standards. The world will reward those who show a willingness to lose themselves in some great cause or in some glorious adventure. The true heroes of a profession are those who have truly kept the faith, those who seek opportunity in order that they may fulfill it. Without thought of personal reward or private gain, the gifted few in succeeding generations, with luminous sincerity and a grave sense of responsibility, have taken the torch from falling hands and held it high. The true torch-bearers of a profession are the unrecognized "millionaires of the spirit" who have ever placed the welfare of the community above personal preference.

So I should say upon this occasion that the things that we desire to have and to hold in every profession are first, personal freedom, which carries with it the responsibility of discharging to the utmost of our ability our individual obligations, second, the interests of common welfare which means upholding the ideals of a group and third social good which means that we should give freely of our talent and skill in the common interests, no matter under what kind of administrative program we may be working.

PRESENTATION OF HONORARY FELLOWS

FRANKLIN H MARTIN M.D. F.A.C.S. CHICAGO, ILLINOIS

AT the Convocation on Friday evening, October 19, Honorary Fellowships were conferred by the President on the following eminent surgeons:

Sir Harold Delf Gillies, London, England—Commander of Order of the Bath of England, Commander of Order of the Dannebrog, Knight Bachelor, Fellow of the Royal College of Surgeons of England, Plastic Surgeon to St. Bartholomew's Hospital. Introduced by Vice President Charles A. Dukes.

Professor Josef Halban, Vienna, Austria—Doctor of Medicine and the Distinguished Professor of Gynecology in the University of Vienna. Introduced by Regent Richard R. Smith.

Mr Harry Platt, Manchester, England—Doctor of Medicine, Master of Surgery, Fellow of the Royal College of Surgeons of England, Lecturer in Orthopedic Surgery at the University of Manchester and President of the British Orthopedic Association. Introduced by Regent John R. Fraser.

Dr Bethel Solomons, Dublin, Ireland—Doctor of Medicine, Fellow and former Vice President of the Royal College of Physicians of Ireland, Examiner in Obstetrics and Gynecology, Royal College of Physicians and Surgeons of Ireland and in Dunham University. Introduced by Regent C. Jeff Miller.

PRESENTATION OF CANDIDATES—CLASS OF 1934

FRANKLIN H. MARTIN, M.D. F.A.C.S. CHICAGO, ILLINOIS

IN behalf of the Board of Regents of the American College of Surgeons, I have the honor to present for Fellowship in the College candidates as follows:

United States	567
Canada	12
Nicaragua	1
China	2
Chosen	2
Bahamas	1
England	1
India	1
Syria	1
Turkey	1
Total	590

Each year as we receive a new class of candidates into Fellowship, I am impressed by the prestige of an institution that can influence such a goodly number of busy practitioners of surgery to seek its portals.

To the casual observer these men and women appear as one more group that is being enrolled into our ranks. Complacently this observer shrugs his shoulders and reflects, "How easy!"

As an illustration let us enumerate the facts. There were 4,983 applications for Fellowship on file January 1, 1934. One thousand one hundred and twenty-six of them were already ap-

proved by their State or Provincial Committees on Credentials. 1,673 were presented to State and Provincial Committees on Credentials during this year. Of these only 639, or 38.2 per cent, were approved and recommended for examination. Of the total recommended for Fellowship before and since January 1, 1934 (1,765) our careful sifting process has admitted to Fellowship only 590, or 33.4 per cent, constituting the candidates who are here present. Of the total 4,983 applications that were on file January 1, 1934, the 590 accepted candidates represent only 11.8 per cent approved, or 1 in every 8 applicants.

Surely if we pay tribute where tribute is due we must pay full portion to the magnificent group which is before us this evening. Veritably they are the survival of the fittest.

They are to be congratulated and the College is to be congratulated but above all, we must congratulate the people who shall in the future seek their services.

Mr President, inasmuch as the candidates herewith presented have fulfilled all of the requirements for admission and have affirmed the Fellowship Pledge of the American College of Surgeons, on authority of the Board of Regents of the College, I take great pleasure in presenting them for Fellowship.

CASE HISTORY HONOR LIST AND PRIZE AWARD

ALLEN B. KANAVEL, M.D. F.A.C.S. CHICAGO ILLINOIS

THE Editorial Board of SURGERY, GYNECOLOGY AND OBSTETRICS is so heartily in sympathy with the program of the College and its demands that all patients should receive careful study as evidenced by adequate records, that in 1930 it asked of the Board of Regents the privilege of presenting an annual prize in the form of a life Fellowship in the American College of Surgeons for the most acceptable set of case records presented by the candidates during the preceding year. The prize consists of five hundred dollars invested in the name of the successful candidate for life dues in the American College of Surgeons, and is accompanied by an appropriately engraved certificate of appreciation on behalf of the donor SURGERY GYNECOLOGY AND OBSTETRICS.

The prize winners of the last 4 years have come from Louisiana, Texas, Montana, and West Virginia respectively.

Forty five histories, outstanding because of their evidence of careful study of the patient, have been selected. These were examined by the full Committee on History Reviews of the College with the name of the surgeon and his address eliminated so that an unbiased choice might be insured. Five sets out of the 45 have been selected as the best and the authors of these records

placed on an honor list. May I ask each honor man to rise as his name is read.

Nicholas Gotten, Philadelphia Pennsylvania
Wallace L. Nelson, Wisconsin Rapids Wisconsin
Roscoe W. Teahan, Philadelphia, Pennsylvania
Harry V. Thomas, Fairmont West Virginia
Clarence H. Snyder, Ann Arbor, Michigan

On behalf of the College I extend to each of you the congratulations of the Board of Regents upon the excellence of your case histories. And now, may I announce the prize winner from among this group and invite him to the platform to receive the certificate of appreciation from our official journal and the formal receipt for life dues in the American College of Surgeons?

Will Dr. Snyder please come to the platform? Dr. Snyder, this recognition of your work is an expression by the College of its belief that scientific investigation, careful records and critical analysis of case history elevates the standard of surgery and insures to patients the most efficient care. It is our hope that this expression of commendation may serve to stimulate others to emulate your example, advance the frontiers of surgical knowledge, and benefit those entrusted to our care. I congratulate you.

SYMPOSIUM CANCER IS CURABLE

THE CURABILITY OF CANCER¹

FRANKLIN H. MARTIN, M.D., CHICAGO, ILLINOIS

Director-General, American College of Surgeons

MAY I cite briefly the objectives which were in my mind when this yearly Symposium on the Curability of Cancer was established in 1932? Through the reports of cancer cures that will follow it is my hope

1 To impress upon the practitioners of scientific medicine, and indirectly upon the public, the fact that carcinoma is curable by the use of well known and established methods of treatment.

2 To point out in a convincing manner that if all cases of cancer could be diagnosed early and treated promptly in their incipency the annual death rate from the disease, now recorded as 150,000 in the United States and Canada, would be reduced by at least 33 per cent, or 50,000 per year. Even if only one half of the cancer cases could be diagnosed early and properly treated, the death rate would be reduced by 25,000 per year.

3 To bring together the group of distinguished clinicians who reported in 1932 and 1933 and those who are here present—an overwhelming authority—to present definite statements of the impressive number of cases of cancer that have actually been cured. This preponderance of evidence, so convincing as an object lesson, will impel ever increasing numbers of the people to demand facilities, through scientific doctors, for annual or semi-annual examinations, so that not only cancer, but any and all diseases may be discovered in their incipency when they are amenable to treatment.

4 To secure the maximum of ethical publicity of the reports. This will furnish convincing evidence to our hospitals, our local medical societies, and our already established clinics, and encourage them to furnish facilities whereby every physician who is practicing scientific medicine will have available the necessary equipment and trained aids to insure the comprehensive examination of his patients.

5 To convince the profession and the public that even though cancer is already apparently in a later stage of its development, if it is subjected to proper treatment, its progress may often be

delayed, and the disease not infrequently cured to make these facts so obvious that a general policy will be established to treat systematically every case of cancer in whatever stage of advance, not only because of the immediate or remote possibility of a cure, but because palliative measures would bring great relief of distressing symptoms, and encouragement instead of forlorn hope.

6 To establish a universal policy among physicians and surgeons to report cancer cures rather than to present the involved comparative statistics that dwell particularly on the cases not cured.

If we here present accomplish the full humanitarian purposes for which this yearly symposium

CANCER CURES—1932, 1933 AND 1934

Cervix	453
Fundus	1,103
Ovary	555
Vagina, vulva, perineum, and urethra	18
Breast	6,457
Mouth and lip	1,551
Stomach	755
Colon and rectum	1,273
Kidney	157
Bladder	34
Prostate	55
Testis	42
Penis	7
Skin	1,060
Thyroid	250
Larynx and hypopharynx	238
Eye	30
Bone	93
Upper jaw and antrum	127
Lower jaw	90
Others	75
Grand total cancer cures 5 years and over	24,440
SOURCES OF CASES REPORTED	
Reported at Clinical Congresses prior to 1934	7,534
Registered cases at American College of Surgeons	1,220
Reported at 1934 Clinical Congress	1,077
Total	24,440

¹This total figure is not higher than reported in 1933 on account of the elimination of incidental cases which have been reported previously by more than one author.

¹Presented at the symposium, Cancer Is Curable, before the Clinical Congress of the American College of Surgeons, Boston, Oct. 4-7, 1934.

was organized the discouraging psychosis that now exists in the minds of the profession as well as the public will be dispelled, a consciousness that cancer is curable will be established in the

minds of all, fear will be displaced by a spirit of hopefulness, and every victim of cancer or suspected cancer will present himself or herself for early diagnosis and treatment.

CANCER SURVIVALS, WITHOUT RECURRENCE, OF FROM FIVE TO TWENTY-FIVE YEARS¹

ROBERT SPANN CATHCART M.D. F.A.C.S. CHARLESTON SOUTH CAROLINA

THIS short résumé of malignant tumors falls roughly into two logical classes. Class I consists of the cases treated in the Roper Hospital, the teaching hospital of the Medical College of the State of South Carolina, which cares for the indigent sick of Charleston—city and county. The patients in this class were seen and attended by some dozen odd surgeons including the author. Class II consists of the private cases of the author that were attended in various other hospitals.

A factor that must be constantly borne in mind in evaluating the statistics is that all of the patients in Class I were free bed cases, most were from the lowest orders of society, and many presented themselves in the last stages of malignant disease. At the other extreme are the private patients of Class II for the most part intelligent and in general consulting the surgeon at a much earlier stage for treatment.

There are, of course, no superficial malignancies included in these statistics.

Class I. Complete records were obtainable in 74 cases between January 1934, and September

1939. There are 6 of these patients still alive, a 5 year survival percentage of 8 (Table I).

Class II. Because of the personal records kept by the author it has been possible to collect 40 cases of cancer dating back as far as 1909. Of these 40 patients treated surgically for cancer 20 are still alive, a survival percentage of 40 plus (Table II).

TABLE II

Organ	Cases treated	Living 5 years or more
Breast	25	16*
Cervix	11	3†
Stomach	6	1‡
Colon	1	0
Ovary	1	0
Total	44	20

*The 16 cases lived 5½ to 5 years. 1 of the dead cases lived over 5 years and died from other causes.

†The 3 cases had radical hysterectomies and died without recurrence.

‡Case of subtotal gastrectomy.

General comment. The surgical treatment (radical mastectomy) of breast cancer has been the most successful in both classes as shown both in the general survival figure and in the survival figure of the special groups.

Breast

Class I, 11 cases Class II, 25 cases
 Alive, 5 (45 per cent) Alive, 16 (64 per cent)
 Total survival per cent of breast 58.
 Total survival per cent of all cases 21.

The very poor survival rate in cancer of the cervix uteri seems to be a combination of two factors, late appearance for treatment and lack of radiation. The latter fault has been completely corrected by the recent installation, in Roper Hospital, of modern deep X-ray therapy and an adequate supply of sufficiently filtered radium. Only widespread public education concerning cancer can get patients to seek medical advice when their malignancy is in its incipency.

TABLE I

Organ	Cases treated	Living 5 years or more
Cervix	27	1*
Fundus	1	0
Breast	11	5†
Stomach	9‡	0
Mouth	6	0
Pancreas	4	0
Bladder	4§	0
Prostate	4	0
Esophagus	4	0
Miscellaneous	4	0
Total	74	6

*The only case treated by radium.

†All cases with lymph node involvement. No radiation used.

‡Exploratory laparotomy on 7. 2 gastrectomies.

§No radium, X-ray or electrocoagulation used.

||No radium, X-ray or surgery.

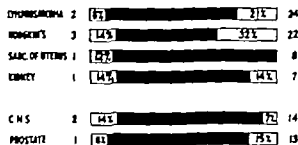


Chart 9 Five years, Group 111

lymphosarcomata lived 8 and 10 years, respectively and 3 of 22 with Hodgkin's disease lived 5, 5 and 6 years, respectively. Of 13 prostatic cancers 1 patient who had both prostatectomy and heavy irradiation died of intercurrent disease 5 years later, but among these 13 radical treatment was the exception rather than the rule (Chart 1).

A summary of this report may be seen from the first composite chart—our follow-up is 86 per cent complete for the entire 596 cases, and is curiously constant for each of the year periods. Time and effort will improve this.

Our average ratio of apparent 5 year cures is 1 in 4, dropping to 1 in 5 for the 10 year series of 166 cases.

Next to the stimulus this review of our own cases gives us to strive for better future results and greater completeness of follow-up its most suggestive feature seems to us the demonstration of the necessity in the case of the less frequent types of cancer for periodic pooling and analysis of comparably recorded data, accumulated by individuals or by large clinics along the lines already laid down by the American College of Surgeons. In that way only can series of the rarer types be secured large enough to be statistically significant.

SOME CANCER CURES¹

MONT R. REID, M.D. AND WILLIAM M. MILLAR, M.D., CINCINNATI, OHIO

From the Department of Surgery of the College of Medicine of the University of Cincinnati and of the Cincinnati General Hospital

IN this report we present two series of figures dealing with cancer. One is taken from the ward cases of the General Hospital of the City of Cincinnati and the second group has been secured from the private records of two of the senior surgeons on the staff of the College of Medicine of the University of Cincinnati.

It should be realized that when the average surgeon or radiologist enters into the field of statistics he is walking upon dangerous ground and figures of comparative methods and medical cures should always be viewed with the greatest caution. In the study of cancer mortality there are entirely too many factors that enter into the question to allow anyone to make any definite statement or to express any positive ideas on the subject. A few of these variables may be briefly mentioned.

A. One should be cautious in dealing with any case below the mean survival age, which is now considered to be about 57 years. For it should be remembered that this is the *mean* age and that below that time a "5 year cure" will become less significant the younger the individual happens to be. Statistically speaking a patient of 35, for example, has a much better expectancy than does a case of 65. This age factor, therefore, has a definite influence on a group of statistics over a wide age period and is too often forgotten by therapeutic enthusiasts.

B. No one knows how many cases of cancer exist for years without symptoms. All of us can recall individuals who have lived 10 to 20 years without operation and who have finally come to see us because of an extensive ulceration or beginning pain.

C. The position of the lesion is important. The new-growth may or may not be where the patient will soon become aware of it. Then, too, the location is important because of the operability factor that is involved.

Space will not permit any further elaboration of the other numerous difficulties involved. However, these points will tend to show that we cannot as yet view the cancer problem from a purely scientific basis for the great reason that we have no proper control of the many variables that exist. It would seem, then, that at the present time the treatment of cancer still depends to a great extent upon two personal equations: the

skill of the doctor and the intelligence of his patient. Everyone will recall cases in which he *knows* that he has helped to prolong life and that if less care had been exercised in his surgery or radiation the patient would have soon died from a metastatic growth. But he cannot *prove* this. He also realizes quite well that the earlier the individual will come to him the better is the chance for a satisfactory result.

PART I

The report which we first present is far from a pleasing one. In an effort to investigate the number of "5 year cancer cures" at the General Hospital of the city of Cincinnati we have examined the histories of 1,098 cases² diagnosed as "malignant" which were admitted to that institution during the years 1920-29.

The end results of 317 of these are not known to us. There is no record to be found in either—(a) the death records of the city's Bureau of Vital Statistics for a 4 year period following their admission to the hospital for a malignant condition, or (b) in the city directory for 1933-34. (Where an individual or individuals with the same name but different address was found in this book, follow up letters were forwarded to them in an effort to secure definite information concerning these missing cases.)

The picture set forth in Tables I and II is dreadful. We offer no "alibis" but these results can be explained in part as due to certain conditions peculiar to a City Charity Hospital.

1. The hospital receives its patients from the lower social classes.

2. Individuals of this stratum tend to put off treatment of any condition until the last possible moment.

3. Hopeless cases are sent into the hospital by the doctors and by families when treatment has become merely a question of proper bed care and opiate therapy. This statement is borne out when it is noted that 463 out of 1,098 died in the hospital.

4. There was a lack of "proper follow up" in the first 9 years of this period. Three hundred and seventeen "unknown" is entirely too great a

²It is possible that all of the cases of cancer admitted to the hospital in that period are not included in this number because of an inadequate filing system for the first few years of that interval.

¹Presented in the symposium, Cancer Is Curable, before the Clinical Congress of the American College of Surgeons, Boston, October 17, 1934.

TABLE I

Total number of cases of known malignancy about whom definite information is available

Total number who died from the disease in the hospital

Total number listed as dead in the city's Bureau of Vital Statistics 4 years after their admission to the hospital

For 3 year cases of proved malignancy

Described cases prospectively malignant from gross description although there is no actual biopsy or macroscopical record of the result

789

463

317

3

Per cent

55.46

40.7

4.14

TABLE II—SOME DETAILS OF THE CASES OF PROVED MALIGNANCY NOW ALIVE

Malignancy of	Color sex, age or admission	Treatment	Actual number years after treatment	Microscopical diagnosis
Breast	W F 51	Radical operation	7	Adenocarcinoma
Breast	W F 45	Radical operation		Adenocarcinoma
Bone (sarcoma)	W F 5	Thigh amputation		Round cell sarcoma
C Colon	W M 40	Resection of cecum with lateral anastomosis	3	Adenocarcinoma
Cervix	W F 40	Supravaginal partial hysterectomy (bilateral S and O)	6	Carcinoma simplex
Hypopharynx	W M 50	Nephrectomy	6	Hypertrophied
Stomach	W M 4	Resection of pylorus	7	Adenocarcinoma
Uterus	W F 63	Partial hysterectomy	9	Adenocarcinoma atret

number. An attempt has been made to remedy this by establishing a tumor clinic at the General Hospital Dispensary (1930). This is now in charge of one doctor who is aided by 3 visiting surgeons, Public Health Federation nurses and a part time secretary.

PART 2

The private records of the senior surgeons of the surgical staff of the Department of the University of Cincinnati (Drs. M. R. Reid and B. N. Carter) were then examined for cases in which operations had been done in Cincinnati prior to 1929.

The actual distribution of cases is shown in Table IV.

Comment. Any comparison which one desires to make with these two groups must be done with the utmost caution. In the first place only two classifications of the private series are large enough to permit an attempt at any evaluation. These are the "stomach" and the "breast" cases. But it will be seen from Tables V and VI that the reduction of them to a percentage basis in order to compare them will allow only the former to be

analyzed and even then the number is too small for any satisfactory conclusions.

SUMMARY

The cases of "5 year cures" which we present are taken from two classifications. One group is from a large series of 789 and has been secured from the records of a large city charity hospital; the other is a small number of 23 and has been taken from the private cases of two general surgeons. We have no great time to elaborate on them. It would seem, however, that one of the chief things now necessary to do and to emphasize is getting the public educated and interested enough in cancer to allow the physician a better chance to be of permanent benefit to his patient. In other words, individuals with cancer should be

TABLE IV—DISTRIBUTION

Cancer location	Total	Living	Dead
Breast	6	6	3
Stomach	3		
Thyroid			
Rectum			
Face—Carcinoma ("large basal")			
Cervix			
Melanoma			3
Oesophagus			6
Retroposterior carcinoma			3
Total	23	11	3

*Small lesions are not included in this list. They would, of course, increase the living group.

TABLE III—PRIVATE CASES

Total cases of known malignancy about whom information is available	Per cent (see Table I)
Total cases of these malignancies which are known to have lived 5 years or more	4
Total cases which are known to have died within 5 years after operation	46
	3.34

Comments. One of the cases which is listed as "dead" was killed in an accident. On the other hand, of the cases regarded as having lived for over 5 years died in the fifth year following her operation. Only 11 of the others are at present living and well.

TABLE V

Total number of actual cases considered—breast	Actual number of breast cases	Percentage of actual total number	Actual number of stomach cases	Percentage of total number
Cincinnati General Hospital series 789	84	10	54	0
"Private" series 24	9	37	5	20

seen in the operable stage and not at the very end. The ordinary charity patient with this disease is seen entirely too late. In our series 59 per cent died in the hospital from malignancy and 40 per cent were dead in 4 years after they had left the hospital. It is true that therapy was instituted in many cases in the desperate hope that the unusual and the miraculous would happen. It did not. There are only 8 people with proved cancer of this group who have lived for 5 years. Contrast this with the private cases. Here we find 11 out of 24 were alive for 5 or more years after their operation.

It can be seen at once that this report may be considered from two diametrically opposite viewpoints. The pessimists will point gloomily at the 99 per cent the optimists will comment on the results of the private group. We are inclined to take our places with the latter, for while it is true

TABLE VI

Stomach cases	Total number with results known	Alive	Percent age	Dead	Percent age
Cincinnati General Hospital series	54	1	06	153	99.04
Private series	5	1	20	4	80

that these two series cannot be compared scientifically and biometrically, for the reasons stated, nevertheless these results tend to show what has been known for years—that cancer can be checked in a very considerable percentage of cases if it is treated early enough.

Furthermore it would seem that the personal equation or rather two personal equations, enter strongly into the whole question. One is the skill of the surgeon the X ray man, or the radiologist, the other is the early co-operation of the patient. The average surgeon and radiologist can generally do a good job nowadays if he has a fair chance. It is now up to the patient to do his part, and it is to this end that the public should be educated.

CONCLUSIONS

1. Caution is advised against any pseudo-scientific attempts to evaluate statistics on cancer.
2. Nineteen proved cancer cases which lived 5 or more years following operation are presented.

FIVE YEAR CURES OF CANCER IN DETROIT HOSPITALS¹

HARRY C. SALTZSTEIN M.D. F.A.C.S. DETROIT MICHIGAN

IN 1927 the Department of Health of Detroit established a cancer division. It functioned (in co-operation with the Wayne County Medical Society) as a registry for the cancer cases treated in all the Detroit hospitals.² The depression and other causes have curtailed the plans and the work but the attempt has been made to follow the cases collected in 1927, 1928, and 1929 for 5 years.

Figures collected in this manner from several different hospitals, with varying degrees of interest and changing organizations, are not as accurate as those obtained under the auspices of one hospital and staff. No case was included unless the pathological diagnosis was recorded but these were not rechecked. (Certain stomach cases, where X-ray and clinical examination were conclusive were accepted.)

Now under the auspices of the Cancer Committee of the Wayne County Medical Society. Dr. O. A. Brown, chairman. This report is published with their approval.

However for the years and body organs stated the attempt was made to include all of the cases treated in the 13 hospitals. Several cancers in other body regions have been cured 5 years, but the number is too small and the total number of cases treated not known accurately enough to be of value. The table therefore, is a fair exhibit of the work from all the general hospitals of a large city (There were no special cancer institutions or concentration of cases.)

The accompanying table shows that in average circumstances—

1. Many breast, cervix and fundus cases are cured regularly. Cures of breast cancer approach the proportion obtained in the carefully compiled series from large institutions.

2. The 5 year accomplishment in stomach cancer is very small. A few rectum and colon cancers are cured 5 years.

3. A few sarcomata are cured 5 years.

Presented at the symposium, Cancer Is Curable, before the Clinical Congress of the American College of Surgeons, Boston, October 27, 1934.

FIVE YEAR CURES OF CANCER IN DETROIT HOSPITALS

Organ	Year	Total cases	Dead	Per cent follow-up	Lost to follow-up	Living 5 years	Per cent living 5 years
Breast	1927, 1928, 1929	282	22	85	99	93	7
Cervix	1928, 1929	57	78	2	43	34	
Fundus uteri	1928, 1929	82	50	85		24	28.6
Stomach	1927, 1928, 1929	156	23		4		1
Rectum	1927, 1928, 1929	80	79			6	7
Colon—including caecum and sigmoid	1928, 1929	90	82			5	5.5
Sarcomas						20	

1. Glioblastoma multiforme, 2. Meningeal sarcoma, 3. Osteogenic sarcoma, 4. Osteosarcoma, 5. Sarcoma uteri. Total number treated is not known.

FIVE YEAR CANCER CURES AT ST LUKE'S HOSPITAL¹

FRANCIS CARTER WOOD M.D., AND BENJAMIN RICE SHORE, M.D. F.A.C.S. NEW YORK, NEW YORK

THE 333 cases which we wish to report represent the known 5 year survivals of patients whose cancers were histologically verified and who were treated in the surgical wards and radiotherapeutic department at St. Luke's Hospital, New York City. Some 110 private patients are included whose histories have been supplied from the personal records of several of the surgeons. All these patients, with a few exceptions, were treated during the 10 year period from 1919, when our follow up department was begun, to 1929. The actual number of 5 year survivals is much greater because many favorable cases have been lost to our follow up department. Patients with recurrences perhaps leading to death, are much more easily followed in a large city than are those who remain well, or who change residence or secure employment in other localities. The ever present suspicious attitude of many clinic patients toward investigators adds to the difficulty of tracing patients in a large community. In New York City great tact and persistence on the part of the surgeons and follow up nurses are necessary if patients are to be followed for a period of years. We have found that much use can be made of the radiotherapeutic department in this respect. Patients who sometimes return reluctantly, or not at all, to the regular follow up clinics for examination will gladly come to the radiotherapeutic clinic for postoperative treatments. It is easy to gauge the latter to the needs of individual patients and many can be persuaded to return for treatments and observation over a long period of time.

A statistical study of cancer therapy at St. Luke's Hospital is not included in the present report. Such a study of 1,000 consecutive patients with cancer admitted to the hospital from July 1, 1923, to January 1, 1927, was made and published several years ago. At that time it was found that only 32 per cent of the patients applying for admission to the hospital had operable growths and known 5 year cures were obtained in 30 per cent of the operable cases, or only 7.8 per cent of the entire number. It is reasonable to suppose that better end-results in cancer therapy depend more on securing patients in the earlier stages of the disease than upon greater refinements in surgical or radiation technique. For the attainment of better results, education—first of the medical profession and second of the laity—appears to be our greatest need today.

The operations on the patients here recorded were performed in St. Luke's Hospital, and histological study of the tumor is available in each case. The slides are on file and many of them have been reviewed for this report. Tumors of questionable malignancy, such as serous papillary cystadenomata of the ovaries and cellular adenomata of the thyroid gland, and patients in whom the duration of life is not accurately known, have been excluded.

Table I shows the sites and character of the growths.

Instead of discussing further these purely statistical results, which differ in no way from those obtained in other hospitals whose surgeons and radiologists are treating cancer patients intelligently and conscientiously, we have selected a few unusual and interesting cases to review.

The first patient had a Grade I squamous cell epithelioma (Fig. 1) of the tongue which was cut into for a biopsy specimen, the wound sutured and a month's time allowed to elapse before the remainder of the lesion was removed. A local excision of the primary growth and a dissection of the right submaxillary triangle were done and the patient has remained well for 19 years.



Fig. 1. Grade I squamous cell epithelioma of the tongue. Patient well 19 years after local excision and dissection of one submaxillary triangle.

¹Presented in the symposium, Cancer Is Curable, before the Clinical Congress of the American College of Surgeons, Boston, October 17, 1934.



Fig 2 Metastatic melanoma in inguinal nodes from primary tumor on sole of foot

The second patient was operated on by Dr F S Mathews for a malignant hypernephroma of the left kidney. This was a huge growth measuring 21 by 13 by 8 centimeters and the prognosis at the time appeared extremely unfavorable. This patient is now entirely well and free of symptoms 7 years after the nephrectomy.



Fig 3 Metastatic melanoma in skin of back. (Same patient as in Fig 2.) Well 5 years after local excision of the primary and metastatic growths by Dr. William A. Downes.

TABLE I—FIVE YEAR SURVIVALS OF CANCER PATIENTS

Carcinoma	
Breast	167
Rectum	20
Body of uterus (all operated upon)	19
Cervix uteri (14 operated upon)	19
(5 radium and biopsy)	
Colon	17
Stomach	12
Lips	11
Ovaries and tubes	7
Buccal cavity	6
Tongue	5
Skin—squamous	5
Skin—basal	5
Vulva	4
Parotid	3
Penis	2
Melanoma	2
Testicle	1
Thyroid	1
Jejunum	1
Gall bladder	1
Branchiogenic	1
Hypernephroma of kidney	1
	310
Sarcoma	
of soft parts	8
of bone	4
Uterine myosarcoma	4
Retroperitoneal sarcoma	3
Leiomyoma of jejunum	2
Lymphosarcoma of neck	1
Myxosarcoma of back	1
	23
Total	333



Fig 4 Spindle cell sarcoma of the toe. Patient well 20 years after amputation of the toe only



Fig 5. Advanced carcinoma of the breast involving the axillary lymph nodes, fat and fascia. Patient died 7 years after radical mastectomy (Courtesy of Dr John Douglas)

A pigmented naevus on the sole of the foot of the third patient was excised locally by Dr William A Downes. Several months later a large mass of coal black lymph nodes containing metastatic melanoma was removed from the inguinal region (Fig 2) and 5 months after this a nodule of metastatic tumor (Fig 3) was removed from the left lumbar region. Since that time there has been no evidence of further dissemination of the growth and the patient has remained well for 15 years.

The tumor in the fourth case was a spindle cell sarcoma of the great toe of an adult patient. A biopsy specimen was taken in the clinic and one week later the toe was amputated. The diagnosis of spindle cell sarcoma was made from histological study of the specimens (Fig 4). This patient has remained well for 20 years.

The last patients which we wish to present are 2 of 6 cases of apparently hopelessly advanced carcinomata of the breast which have survived for over 5 years after what at the time were



Fig 6. Advanced carcinoma originating in the axillary tail of the breast. Axillary nodes extensively involved. Patient well 8 years after radical mastectomy (Courtesy of Dr M. K. Smith)

thought to be purely palliative radical mastectomies. In both of these instances the primary tumors were large and metastatic cancer was found not only in the axillary lymph nodes but also involving the axillary fat and fascia (Figs. 5 and 6)

These cases have been reviewed to show that neither the histological nor clinical grading of tumors can be relied upon for the correct prognosis in the individual case and that to obtain the best results in cancer therapy all growths no matter how advanced, must be treated in a thorough and intelligent manner. The biology of the patient and the biology of the tumor which he harbors are the two great unknowns present in every case of cancer.

CANCER OF THE BREAST IS CURABLE¹

THOMAS A. SHALLOW, M.D., F.A.C.S., PHILADELPHIA, PENNSYLVANIA

WHEN one considers the statistics of the past 30 years, one must admit that cancer of the breast is a curable condition. This conclusion is reached after a careful summing up of the reported cases of malignancy of the breast in which the patients have remained well beyond the 10 year period, even when they came to the operating table under the most adverse circumstances. One would naturally conclude that, in the average case which comes to the operating table, the growth has existed from between 6 and 12 months, and in 75 per cent of the cases metastasis has involved the adjacent lymphatics, while in over 67 per cent of the cases the skin is adherent to the tumor. In other words, a well advanced cancer is the rule rather than the exception when the surgeon first sees it.

The operation for carcinoma of the breast is not attended with any great shock, nor is any vital structure destroyed, yet, because of its anatomical situation, perfect exposure is possible not only of the involved breast, but also of the adjacent muscles, the fascia and the lymphatics.

Is surgery alone sufficient for the cure of cancer? In this series of cases, surgery has been fortified by postoperative X-ray treatment. We have seen beneficial results in 2 cases, postoperatively where the carcinoma had spread to the ribs in one patient and to the spine in the other. In both of these patients, following intensive X-ray treatments, the metastatic areas disappeared and were replaced by what apparently was normal bone structure. In one case the patient is still living 7 years after the beginning of the X-ray therapy and the other 12 years after her operation.

We have noted further that in those patients in whom postoperative treatments were faithfully carried out, local recurrences and distant recurrences were the exception. But, on the contrary, in those individuals who did not report for postoperative X-ray treatment, local recurrences were more common.

The cure of cancer must depend upon its early recognition. This is only possible through intensive propaganda among female patients and the medical practitioners. It has been stated previously that carcinoma is seldom recognized before the sixth month and usually not before the twelfth. This golden period of formation, localizing growth, limited involvement without metas-

tasis, is the ideal time for surgical intervention. Then carcinoma is curable in certainly 70 per cent of the cases.

We cannot blame the medical man for not making an early diagnosis of carcinoma of the breast, particularly when carcinoma is associated with chronic interstitial mastitis. We are told by good authority that a chronic mastitis is very frequently a forerunner of cancer. This statement is disputed by others of equally good authority. What is the medical man to believe? We should teach him that carcinoma of the breast can and does originate in breasts in which there is chronic mastitis. In this series of 100 cases, 32 patients had definite chronic mastitis and the cancer was not recognized because they were told that cancer was never painful until the end. Most of them had consulted physicians and were given some form of glandular therapy with the hope that a cure would be effected.

We have been teaching for so long the characteristic phenomena associated with the well advanced carcinoma that very frequently mistakes are made. In 3 cases that I recall distinctly at this time, younger surgeons in one of the hospitals with which I am associated removed small tumors from the breasts as finishing touches to abdominal operations, believing that they were dealing with benign growths. The pathological reports returned in 2 weeks after the removal of these growths showed cancer in every case. When questioned about his work the surgeon's answer was, "I thought it was an area of mastitis." Had a frozen section been made, the true nature of the pathology would have been disclosed and a radical operation would have given us 3 excellent cases for cure.

Tumors of the breast should not be the tail of a kite, such as these 3 cases were, but, on the contrary they should be considered of the utmost importance from the standpoint of the patient and the preparation of the surgeon for the procedure.

Within recent years the differential diagnosis between cysts and solid tumors has been made possible by Cutler's method of transillumination of the breast. This is indeed a help in separating some of the benign cystic tumors from malignant ones. X-ray studies of the breast have added, even more than transillumination, to early diagnosis. Both of these methods, however should be used to their fullest extent. If the aver-

¹Presented at the symposium, Cancer Is Curable before the Clinical Congress of the American College of Surgeons, Boston, October 17, 1924.

TABLE I—FREQUENCY DISTRIBUTION AS TO METASTASIS AT TIME OF OPERATION

With metastasis at time of operation	63
Without metastasis at time of operation	26
Unknown	9

TABLE II—FREQUENCY DISTRIBUTION AS TO THE PATHOLOGICAL DIAGNOSIS

Type of carcinoma	Total number of cases	Per cent of cases
Scirrhus	52	52
Medullary	17	17
Adenocarcinoma	7	7
Paget's	4	4
Carcinoma	10	10
Colloid	1	1
Comedo	1	1
Papillary	7	7
Sarcoma	1	1

age case were looked upon as a potential malignancy, it would lead to earlier operative intervention and a higher percentage of cures. One often wonders why some of our patients with cancer of the breast live as long as they do since they are very frequently far advanced before they come to the operating surgeon.

The prognosis and treatment of cancer of the breast will be improved when (a) the medical man loses the time worn expression 'If it doesn't bother you let it alone,' (b) the diagnosis of carcinoma is made before the skin is adherent

TABLE III—MARITAL STATUS

Married	84
Single	15
Status unknown	5

TABLE IV—DURATION OF LIFE IN YEARS AFTER OPERATION

Length of life	Number of cases
13 years or over	1
12 years or over	2
11 years or over	3
10 years or over	3
9 years or over	5
8 years or over	4
7 years or over	4
6 years or over	4
5 years or over	4

and before the adjacent lymphatic glands are involved.

Improvement in prognosis and treatment can be accomplished not only clinically, but by the aid of transillumination and X ray examination, when the medical man realizes that it is not uncommon for carcinoma to develop in a breast in which there is chronic mastitis. Thirty two patients out of the series of 100 reported here had had mastitis.

Moreover, progress will occur when we realize that in those patients in whom there is a discharge either of blood or of clear fluid from the nipple the likelihood of carcinoma is about 40 per cent.

FIVE YEAR CURES OF CANCER OF THE BREAST AND OF MELANOMA¹

A. C. SCOTT, JR., M.D. F.A.C.S., Temple, Texas

WE believe that 95 out of every 100 patients with cancer of the breast can be cured today. This statement is based on our experience during the past 15 years in treating 3,167 patients with various types of cancer, and an intensive follow up study of 236 breast cancer cases treated by hot knife surgical removal.

The only conditions necessary to obtain this high percentage of cures are first, treatment while the tumor is limited within the breast, and second, complete removal with the hot loop-knife.

The ratio of curability of cancer is dependent today upon three known factors: the time after onset when the patient seeks treatment, the curative agent employed, and the degree of malignancy. The first two factors are more or less controllable by the medical profession.

It has often been stated in recent years by excellent authorities that the only hope at present for increasing the percentage of cures lies in educating the public to seek treatment earlier, and that very little can be expected from improvement of surgical technique. The impression has been given and is being broadcast that surgery has reached its limit as a curative agent. We disagree with this view.

We are convinced that hot knife surgical removal offers a 10 to 20 per cent better chance of cure of cancer of the breast, even though metastasis to the axilla may have occurred, than the use of any other curative agent known.

In 1926 I presented a study of 1,000 cases of various types of cancer treated by this method and on numerous occasions Dr. A. C. Scott, Sr.

has described the technique of the hot loop-knife operation. In the series of 3 167 cancers treated in our clinic between the years 1918-1933 inclusive, it was the principal remedial agent employed in 86 per cent of the cases. I am not prepared at this time to report the 5 year cures of the entire series, but I will briefly report 2 small 5 year groups of totally different types of cancer treated by this method.

Cancer of the breast. The first radical breast amputation and gland dissection performed exclusively with the hot loop-knife was done in our clinic in 1920 and between that time and the end of 1933 236 similar operations were performed for cancer of the breast. Of this group only 124 patients have been operated on 5 years or longer and 58 patients of the entire 5 year group were alive and well at the end of this period.

In this group of 124 patients, 16 had received various types of surgical interference elsewhere before entry and 1 had received extensive X ray therapy. 107 patients had their primary treatment in our clinic.

In the group receiving primary treatment in our clinic 18 operations were considered palliative because of one or more of the following conditions: chest wall attachment, diffuse skin involvement, fixation of axillary metastasis, indurated cervical glands or probable distant metastases as indicated by X ray changes of lung, pleura, or bone.

Eighty nine patients were considered operable and potentially curable, irrespective of whether or not they had palpable axillary metastases. Eighty four of this operable group have been traced. Fifty two patients or 61.9 per cent were alive and well 5 years or longer.

Fifty four patients of the operable group had proved axillary gland metastasis. Fifty of these were traced. 24 died of cancer, 4 died of intercurrent disease or other causes. Twenty two patients or 44 per cent of this group of traced patients were well 5 years later. If the patients who died

of intercurrent disease are eliminated, 22 of the 46 traced patients, or 47.8 per cent, lived 5 years.

Thirty-five patients of the operable group had no pathological evidence of regional gland metastasis. Thirty four of these were traced. 1 died of cancer, 3 died of other known causes. Thirty patients or 88.2 per cent of this group of traced patients were well 5 years. If the patients who died of intercurrent disease are eliminated, 30 of the 31 traced patients, or 96. per cent were well 5 years later.

Malignant melanoma. Malignant melanoma, variously termed melanosarcoma, melano-epithelioma, non-melanotic melano-epithelioma, neuro-carcinoma, etc., is generally conceded to be one of the most malignant of all types of cancer and almost inevitably fatal. We have operated with the hot-loop-knife on 53 patients with this condition in an attempt to cure, and have traced 46 of these. Twenty nine of the traced patients had been operated on 5 years or longer prior to 1934. Although this is a very small series, our results in treating this most malignant and hopeless type of cancer have so startled us that I think they are worthy of presentation.

Of the 29 patients, 11 or 37.9 per cent were alive and well 5 years or longer. Ten of the 29 had regional gland dissections with demonstrable metastasis and 3 patients, or 30 per cent of those with metastases were alive and well 5 years. Of the 11 five year cures, 4 had Grade II, 6 had Grade III, and 1 had Grade IV malignant melanoma.

SUMMARY

A greater number of patients are being cured of cancer today than ever before, alive by radiologists and surgeons, but we are convinced that a still greater percentage of all surface and accessible subsurface cancers can be cured by the more general use of the hot loop-knife for complete removal.

FIVE YEAR CURES OF CANCER OF THE STOMACH¹

RICHARD LEWISOHN M.D. F.A.C.S., AND SIGMUND MAGE M.D. F.A.C.S., NEW YORK, NEW YORK
From the Surgical Service Mount Sinai Hospital

CANCER of the stomach represents a fatal disease unless attacked surgically. In contradistinction to cancerous growths in other locations (mouth skin uterus), which can be cured by radiotherapy in a large percentage of cases, surgery represents the only possible curative method for gastric carcinoma.

In view of the absolute hopelessness of this disease unless removed by operation, we agree with Dr. A. A. Berg who was in charge of this service until recently that no attempt should be made to keep the operative mortality for gastric carcinoma at a low level by refusing to subject patients to radical resection who are at the borderline of operability.

The high operative mortality of cancer of the stomach on this service (33 per cent) is undoubtedly due to many daring attempts to remove the carcinoma even in extensive growths with local metastasis, instead of classifying the patients as definitely inoperable.

Six hundred and forty seven patients with carcinoma of the stomach were admitted to Mount Sinai Hospital between January 1, 1922, and January 1, 1932. Two hundred and sixty five

were explored, in the rest, either the condition was found definitely inoperable on account of metastasis in other organs, or operation was refused.

Ninety three radical resections were performed, the remaining 172 cases (65 per cent) were inoperable. The high incidence of inoperability encountered even on this service which tried to extend the limits of operation as much as possible re-emphasizes the urgent need for early investigation of indefinite gastric complaints by roentgenography.

We were able to maintain a complete follow up on 88 per cent of the cases operated upon between the years 1922 and 1931 inclusive. Our follow up records on cancer of the stomach previous to 1922 are very incomplete.

We know of 10 cases of carcinoma of the stomach which have been well for 5 years or more following gastric resection (see table). In 3 of these cases the operation was performed more than 10 years ago.

Only 2 of these patients were below 50 years of age at the time of the operation. It is generally conceded that as a rule cancer in persons under

FIVE TO EIGHTEEN YEAR CURES OF CANCER OF THE STOMACH

No.	Year	Name	Hospital record	Age	Duration of symptoms	Palpation	Operator	Pathology	Other notes	Duration of cure
1	1916	Flis B.	40-47	35	3 months. Diabetes since 14	Negative	Lewisoohn	Colloid adenocarcinoma	Adhesions to pancreas	18 years
2	919	Jacob J.	40-41	63	4 months	Negative	Lewisoohn	Carcinoma solidum		15 years
3	1923	Jacob H.	40-49	3	6 weeks	Negative	Berg	Gyphoid cell carcinoma; lymph nodes involved		12 years
4	904	William H.	40-49	35	6-7 years	Small mass	Lewisoohn	Adenocarcinoma, lymph nodes not involved	Admitted with acute hemorrhage, Billroth I.	10 years
5	905	Joseph D.	40-	34	3 months	Movable mass	Berg	Adenocarcinoma, lymph nodes not involved		9 years
6	907	Rose S.	34-40	35	1 year	Negative	Edelman	Adenocarcinoma, lymph nodes not involved	Previous admission to medical service 6 months ago	7 years
7	917	Kathleen B.	37-41.4	37	5 years	Negative	Berg	Carcinoma developing on ulcer		7 years
8	917	Genove Z.	39-44.6	3	9 years	Hard, irregular mass	Berg	Adenocarcinoma, lymph nodes involved		7 years
9	1929	Eugene I.	39-44.7	43	1 year	Negative	Gerriter	Infiltrating adenocarcinoma		5 years
10	930	Chas. K.	39-45.6	35	18 years	Negative	Achmer	Adenocarcinoma with lymph node involvement probably on ulcer basis		3 years

50 is more malignant and gives a less favorable chance for radical cure than in persons past the fifth decade.

Seven patients were males and 3 were females.

Gastric symptoms had been present for a year or more in 6 cases. It is often stated, even by experienced practitioners, that abdominal exploration should not be performed if symptoms have persisted over a fairly long period. In this series 6 cases were amenable to radical surgery in spite of the fact that in 3 cases symptoms had been present for 1 year and in 4 cases for a number of years. In those cases in which the symptoms had persisted for 5, 6, 10 and 18 years respectively, the carcinoma probably developed on an old gastric ulcer.

In 7 cases no mass was palpable. 3 cases (30 per cent) could be subjected to gastric resection, in spite of the pre-operative palpatory findings of a hard tumor in the upper abdomen. The dictum that palpable masses definitely indicate inoperability is as much a fallacy as the statement that

absence of a palpable mass excludes a malignancy of the stomach.

In 9 cases the Billroth II method was used and in 1 case a Billroth I. The Billroth II method is preferable in carcinoma of the stomach, as it facilitates a wide resection of the new-growth.

It is of great interest to note that the microscopic examination showed lymph node involvement in 4 of these cases. We have always maintained that local metastasis is no contra indication to radical operation.

Thus in our material about 20 per cent of the resected cases of gastric carcinoma surviving the operation were still perfectly well after 5 years or more. Gastric carcinoma does not offer a hopeless prognosis and under certain conditions has about the same chance for a permanent cure as cancer in some other parts of the body.

For this reason partial or subtotal gastrectomy should be attempted even in extensive involvement of the stomach as the only possible chance for a permanent cure.

CANCER IS CURABLE¹

FREDERICK C. HOLDEN M.D. F.A.C.S., New York, New York

SINCE cancer of the cervix still remains so formidable a foe, we must marshal our most powerful forces to continue fight ing it.

Our program is threefold

1 Further research in the etiology, diagnosis, and treatment.

2 Prevention or cure of the pathological condition which predisposes to cancer

3 Education of the profession and laity to make full use of the knowledge and facilities already available to them.

I wish to stress the two last points. Prevention of disease is the ideal toward which we strive. The most important measure in the prevention of cancer of the cervix is the repair of the damages of childbirth either immediately after delivery or preferably 4 to 8 weeks later. In many instances cervical injury can be cleared up by proper use of the nasal tip cautery at the 6 weeks' postnatal visit. R. L. Dickinson and the author have for many years used the nasal tip cautery for the cure of lacerated and eroded cervixes, and have never seen carcinoma develop in a cervix so treated by them. The laity especially must be educated to the fact that postnatal care of the cervix is the most important measure for preventing cancer of the cervix.

We do not approve of routine total hysterectomies and think this operation because of its increased mortality and morbidity should be reserved for those cases in which it is definitely indicated. However there is a small percentage of cases wherein cancer develops in the retained cervix after a supravaginal hysterectomy. This percentage could be almost entirely eliminated if the entire endocervical canal and eroded areas are thoroughly cauterized 4 to 6 weeks after operation.

Another important step in the educational program is to dispel the almost universal belief that a diagnosis of cancer carries with it certain death. Cancer is curable if the diagnosis is made early enough, therefore we must exert all our energies to reach the cancer patient in the initial stage. This is not as simple as it sounds, for although many educational campaigns have been carried out to teach the public what the early symptoms of cancer may be still, early symptoms do not mean an early stage of the disease. Cancer in its initial stage has no symptoms, and herein lies its

greatest danger. For this reason, in order to bring the cancer patient to the doctor early, I strongly advocate yearly general examinations, including a careful pelvic examination for every woman. Too often many symptoms are casually dismissed by the patient as 'Oh! It's the change of life,' and so, during this period, these examinations should be carried out every 6 months.

The inherent danger of vaginal discharge, irregular vaginal bleeding, postcoital and postmenopausal bleeding, or abdominal mass, should be brought to the consciousness of every woman, but again I stress the point that only by routine pelvic examinations will early cancer of the cervix

REPORT OF CERVIX CASES 1925 TO 1933

Cases		951
Married		38
Single		9
Marital status unknown		4
Childbirth		
None		
1 child each	32	5 Cases—1925 11
2 children each	45	14 Cases—1926 6
3 children each	30	5 Cases—1927 6
4 children each	33	15 Cases—1928 8
5 children each	20	14 Cases—1929 11
Over 5 children each	16	35 Cases—1930 11
Unknown	54	33 Cases—1931 0
		47 Cases—93 6
		34 Cases—1933 6
Total		80
Age		
20-30		4
31-40		80
41-50		84
51-60		90
60 and over		11
Unknown		3
Pathology		
Menstrua		1 7
Menstrua: Squamous cell type		1 7
Menstrua: Transitional cell type		1 7
Menstrua: Spindle cell type		2
Menstrua: Transitional and squamous cell type		7
Menstrua: Transitional and spindle cell type		2
Menstrua: Squamous and spindle cell type		8
Squamous		64
Basal cell		2
Adenocarcinoma		18
Transitional cell		7
Carcinoma		2
Fibrosarcoma		1
Epithelioma		1
Epithelioma adenoid type		1
Undifferentiated		7
Reoper elsewhere		3
Patients known to be living after radiation treatment		
Number of patients accepted according to year admitted		
Cases	Year	Cases
1 year	1925	13
1 to 2 years	1926	14
2 to 3 years	1927	14
3 to 4 years	1928	14
4 to 5 years	1929	14
5 to 6 years	1930	14
6 to 7 years	1931	14
7 to 8 years	1932	14
	1933	47

be detected and the probability of cure greatly increased thereby

In reporting our cancer series at Bellevue Hospital, I am presenting the darkest side of the picture, because of the economic status of our patients. This factor in itself bears out the above points. The incidence of cancer of the cervix is much higher in the poorer classes than in the well-to-do, since the early initial symptoms which are given immediate attention by the well-to-do are either overlooked or disregarded by poor overworked women. To illustrate, we have never received a Group I case for treatment. Also in this class of patients we are greatly handicapped by lack of co-operation in the follow-up and proper after-care. Even with this most discouraging group we have some cures to report. With a higher economic group the cures would be greatly increased, showing what education and early care can accomplish.

At Bellevue Hospital for the past 9 years, irradiation has been used exclusively for cancer of the cervix. All cases were biopsied and classi-

fied pathologically. In our experience the pathological findings have not helped us to prognosticate the course of the disease but they have aided in planning the dosage of radium to be used in any given case. Fistulae did not develop in any of these cases.

SUMMARY

Healing the injured cervix by proper postnatal care, is the most important prophylactic measure for cancer of the cervix.

We advise routine thorough cauterization of the endocervical canal and of the retained cervix following supravaginal hysterectomy.

Early cancer of the cervix gives no symptoms. For this reason, periodic general pelvic examinations should be carefully done. By this means it is possible to detect benign cervical lesions, which can then be treated, or to discover an early cancer if present.

The public should be educated as to what symptoms require immediate attention.

There is no cancer age.

Cancer is curable if treated early and properly.

CANCER OF THE CERVIX.¹

C. JEFF MILLER, M.D. F.A.C.S. NEW ORLEANS, LOUISIANA

THE intent of this symposium, as I understand it, is to present incontrovertible proof of the curability of cancer by collecting a large series of cases that have been treated and have remained well and free from active malignancy for more than 5 years. The report must necessarily be brief and for that reason I have not arranged a statistical study but will simply present the results, as obtained by letters to patients and physicians, in a series of private cases treated prior to 1929. The report is limited to private records because it was impossible to make necessary inquiries and checks of the large amount of material that passed through the wards and clinics of the busy services under my direction in two public institutions. Even the collection of data from private patients proves a tedious task, for as usual, a great many ignored written requests.

The oldest living case in my series was first treated in 1908. I can definitely report that 42 patients treated between 1908 and 1929 for cancer of the cervix have reported personally or through their physicians, that they are well. Eight of

these cases were treated by radical hysterectomy between the years 1908 and 1915. After 1915 only 3 radical hysterectomies were performed, as I had become convinced that too much confusion existed as to the clinical classification of early borderline and advanced cervical cancer that the primary mortality of the correctly performed radical hysterectomy was too high, and that over 70 per cent of cases applying for treatment had to be thrown into the discard as unsuitable for anything more than palliative measures. After 1915 radium was used in all cases early and advanced. Of those treated between 1914 and 1929, 34 recently reported that they have remained well. Twelve of this number had X-ray treatment in addition to radium. The cases subjected to combined irradiation were treated between 1922 and 1929 and as a rule were more advanced. The results in this series have convinced me of the advantages of this method. In addition to irradiation, the electrocautery was freely used in removing overlying, crumbling cervixes, and Norris' suggestion for separating raising and packing away the bladder with gauze during the irradiation.

tion (to prevent subsequent complications), was occasionally done. Most of the cases received within one week from 3,000 to 4,000 milligram hours, and subsequent radium exposures were given only for definite reasons. Repeated treatments every 60 or 90 days, as advocated by some clinicians too often result in fistulae and other complications to warrant the adoption of this method as routine.

My report is brief but I wish to emphasize one or two features of the cancer problem that are equally as important as presenting a series of cured cases. May I speak briefly of the necessity of creating a different attitude on the part of the physician who is brought in contact with patients *who seem to indicate the possibility of cancer?* If cancer is to be detected earlier, this must not be accomplished merely by the ability to recognize cancer but by appreciating as well the relation of other diseases to malignancy. Proper prophylaxis of cancer will yield greater salvage of lives than can be obtained by our present available methods of treatment. Further education of the profession is necessary. Frankly, since we believe that cancer is originally a local process, are we consistent in teaching that the early signs of cancer of the cervix are bleeding, discharge, and pain? Are we not summarizing as early signs of malignancy the indications of impending death rather than the symptoms of cancer? A new clinical entity must be described to replace the present stereotyped syndrome.

'Cancer does not have a life history of a few months or a year, but is a disease that usually takes several years to run its full course' (McCarthy). The word *early*, which we use so freely, must be more clearly defined. Many of the really early cases of cancer of the cervix are found by accident when routine microscopic examination

of cervical tissues removed in performing plastic operations is done. Such routine study should be required in all hospitals, as properly performed biopsies are not done as often as their importance justifies. Biopsy should be the rule not only in suspected cancer, but in apparently simple chronic inflammatory lesions and obstetrical injuries.

The physician must be kept cancer-conscious. For this the Schiller test is excellent. While not a positive test for cancer, it prompts the routine search for malignancy, and materially assists in differentiating other lesions not recognizable by ordinary inspection. It is especially useful in designating tissues to be removed for microscopic study. The same can be said in regard to the colposcope in the diagnosis of suspicious lesions.

It is certainly permissible to question whether the lay education has been as thorough as it might have been. It has been carried far enough to prove its vast possibilities, yet in our large charity hospitals over 20 per cent of cancer patients are dying without having had either surgery or irradiation. The lay press and the radio are co-operative, but we are overlooking the fundamentals of publicity, viz., repetition and perseverance. The agencies of publicity should be persistently utilized, not to relate the horrors of cancer, nor to emphasize the number who die from it annually but to instill hope, and to disseminate knowledge concerning the value of routine health examinations, not, as Lord Moynehan says, 'by scaring people to death but scaring them into life.'

These are commonplace comments but they are truths worth repeating. 'Commonplace after all is exactly what contains the truth that is indispensable' (John Morley)

CANCER OF THE BREAST¹

W T COUGHLIN, M D F.A.C.S. St. Louis, Missouri

IN the city of St. Louis, 10 or 11 persons out of every 100,000 die each year of cancer of the breast. Surgeons' statistics are usually compiled from the cases in the large clinics. Most of us present are more interested in what happens in our individual practices. Every surgeon keeps personal records of his cases, uses the follow up and from time to time takes stock and knows just how he stands. It isn't always pleasant but it is highly desirable.

Up to 1929 the author treated 104 private patients (and took care of them himself) under the diagnosis of breast tumor. In these the presence of cancer was proved microscopically 63 times (All of these 63 were private patients and all were white females.) Therefore, the benign lesions were 41. Roughly speaking 2 out of every 5 were benign and 3 out of every 5 were cancer. This is a high percentage of benign tumors. Thirty years ago we taught that at least 4 out of every 5 lumps in a woman's breast were cancer. This was considered a conservative estimate. The difference is due to the propaganda for early diagnosis. Through our propaganda, at last the laity is beginning to know this truth about cancer of the breast (as through the long years the surgeons have taught them of appendicitis) namely that in early operation lies the best hope of cure, and that, in fact, no other treatment up to the present in any way approaches in its results those obtained by early and efficient operation. When all physicians believe this truth—that any lump must be removed and examined microscopically in order to be sure that it is *not* cancer—the laity will soon learn it.

We have 63 cases for study. Of the 63 coming to operation there were still living at the end of 5 years, 29 patients. Six of the 63 had died in the hospital. Twenty-two of the 63 died of cancer within 5 years—11 within 1 year, 8 within 2 years, 1 within 3 years, and 4 within 4 years. Two are positively known to have died of other causes within 3 years—1 of pneumonia and 1 of an acute heart attack. Four could not be traced.

Our total number of cases living 5 years after operation was 29, or 46 per cent. Of these 29, 4 died later of metastatic carcinoma, 1 patient being free of any recurrence for 8 years and then dying of cancer of the fourth lumbar vertebra, proved at autopsy to be breast carcinoma; another one, having had a scirrhous cancer with implants

tion in the axillary glands, lived free from recurrence for 8 years and then died of cancer of the uterus; another lived free of recurrence and then died 6 years after operation with symptoms of spinal cord tumor—most likely carcinoma of the vertebrae; another died 5½ years after operation of metastatic cancer of lungs and bones. Of the 29, 1 lived free of symptoms for 10 years and then came with a recurrent nodule in the scar; another comes 6 years after operation with destruction of the twelfth dorsal vertebra.

Of those who died early, the average pre-operative duration of the disease was 19 months. Of those who lived 5 years or longer, it was 13 months. Of the 29 who lived 5 years or longer, 5 were known to have had cancer in the glands. Of the 22 who died early, 16 were known to have had cancer in the glands of the axilla or neck. Of the 63 proved cases of cancer, 29 had nursed babies. In the 29 five year cures, 13 had nursed babies. Of the 22 who died early, 11 had nursed babies.

With regard to heredity, the statistics do not mean much. People deny cancer in the family just as they deny insanity, so that the statements of the patient in the negative cannot be accepted without question. There were only 8 of the 63 patients who acknowledged cancer in the immediate family—father, mother, brother or sister. Of these, 7 lived 5 years and the other one could not be traced.

Of the 63 cases, there were 31 involving the right breast, 29 involving the left breast and 3 involving both breasts. Of the 29 five year cures, 11 involved the right breast, 15 the left breast and 3 involved both breasts. Of the 22 early deaths, 15 were of the right breast and 7 were of the left.

At the present time the exact status of chronic cystic mastitis is very much discussed. In our series of 104, that diagnosis was made altogether 23 times, and 9 times out of these 23 it was associated with cancer of the breast. One case in which frozen section diagnosis was questionable, and in which breast and lower glands were removed, after 6 years has developed a destructive process in the twelfth dorsal vertebra and is still living. Another one in whom the diagnosis "chronic cystic mastitis" was returned without question and in whom a similar operation was done, returned the next year with a nodule in the

breast region which was pronounced by the same pathologist "scirrhous carcinoma of the breast." Nine out of 23 cases of chronic cystic mastitis had microscopically proved carcinoma.

There are 8 different cell types named. There is no unanimity among the pathologists with regard to terminology. Of the 29 who lived 5 years or longer—

- 9 were called adenocarcinoma
- 8 were called scirrhous carcinoma
- 5 were called carcinoma simplex

- 4 were called medullary carcinoma
- 1 was called colloid carcinoma
- 1 was called duct carcinoma
- 1 the type was not mentioned.

Of the 22 who died early—

- 7 were called scirrhous carcinoma
- 4 were called medullary carcinoma
- 4 were called carcinoma simplex
- 3 were called adenocarcinoma
- 1 was called basal cell type carcinoma
- 1 was called spheroidal cell carcinoma
- 1 was called sarcoma round and spindle cell
- 1 the type was not mentioned.

CANCER OF THE BREAST IS CURABLE¹

HUBERT A. ROYSTER, M.D., F.A.C.S. RALEIGH, NORTH CAROLINA

CANCER is a symptomless disease. There are no pathognomonic signs of its presence in any organ or tissue. It may exist in the internal organs for a comparatively long time without a disturbance of function or a suspicion of its presence. In its late hopeless stages cancer of any part of the body exhibits pain, ulceration, discharge and cachexia, but these are not symptoms of cancer; they are signs of impending death.

The female breast should be one of the locations in which cancer is recognized early, for the breast is exposed to observation both of patient and physician. Unfortunately the woman frequently fails to notice changes in the contour of the breast and, as pain is virtually never felt in the early stages of malignant disease her attention is seldom called to the occurrence of a tumor of this type until it is far advanced. On the contrary, early pain is present in tumors which are benign, and these are recognized much more promptly. Actually I believe that, thanks to wide spread publicity and educational efforts, we are observing as many benign as malignant growths of the female breast, if not more, in the past 10 years. This is real progress. All our experience and all our diagnostic judgment applied to the decision as to whether a given tumor of the breast is benign or malignant, can be laid aside in the face of one issue—the presence of any growth in the breast is the reason for its removal. Women generally must be taught a safe slogan: an empty house is better than a poor tenant—remove that lump.

These preliminary observations point the way to two facts upon which the cure of cancer of the breast depends: (1) securing the patient before metastasis has taken place and (2) thorough surgical removal of all involved tissues. The question of employing radiation in any form, either before or after operation, is of importance but radiation should be considered only as an aid in the cases suitable for operative interference. Personally I have depended upon postoperative in preference to pre-operative radiation. This procedure is, of course, open to argument. Every surgeon must follow his own predilections founded upon individual experience. I have always been afraid that, if I relied too much on what the radiologist could accomplish before operation, I might be tempted to do a less radical removal of the cancer and its surrounding areas. At any

rate, although for chosen patients I use radiation beforehand, in some cases I have felt disappointed in the results and in others I have failed to see the necessity for its use; and still I have looked upon proper postoperative radiation as a ready resource whenever a complete operation may have failed. The use of pre-operative radiation might likewise be considered useful, but in a few of the cases that received prolonged treatment by X-ray the skin and deeper areas were profoundly indurated, offering difficulties at operation; one case exhibited severe and almost uncontrollable oozing. Be that as it may, my object in referring to these methods is to emphasize my belief that any mammary cancer in the curable stage should be totally extirpated by a surgical operation done in the most adequate and finished manner possible. Methods of palliation or those used to prolong life over a certain period form no part of this discourse.

I wish to mention briefly and without tedious tabulation that I have records of 58 personal cases of cancer of the breast among those operated on from 1911 to 1939, all of whom lived beyond 5 years and some of whom are now living and well after 20 years. I have eliminated all who died from any cause whatever within 5 years after the operation, although I know that some of these did not die of cancer. The total number of operations (196) is unimportant, as I take it we are concerned here with reporting all our cured cases irrespective of percentages. Many of the cases as far back as 30 years ago were really inoperable but their breasts were removed to obviate local recurrence or for cosmetic purposes. At that time patients did not come so early; neither did we have improved radiology to help us. In point of time the first case of the series dates back to 1911; the patient was then aged 67 and lived about 15 years. The oldest patient was 70 years of age operated upon in 1914 and died in 1934 of pneumonia with pleural effusion. The youngest patient, 25 years of age operated on in 1915, is still living and well. Forty of the patients were white and 18 colored. The last patient included in the report was operated on February 20, 1939, and is now without recurrence. Less than half of all the patients received no radiation treatment. For the past 10 years practically every one had postoperative X-ray therapy; a few were radiated pre-operatively as well. Of the 58 patients fol-

lowed up to date and here reported as 5 year cures, 6 are considered to have died of metastasis after 5 years and 3 died of what appeared to be some form of malignancy after 10 years.

The remainder, 49 in number are either alive without recurrence or died of some intercurrent disease not connected with their breast cancers long after the limit of cure.

I am aware that this report sets no notable example. I am aware also, that the survivors represent the most favorable types of breast malignancy, both from the clinical aspects and from what we would now regard as pathological

grading. But I am equally conscious that here are all but a half hundred women who have lived out their expectancy as a result of the surgical removal of an organ affected with cancer from which they would eventually have died, if this dread disease had not been recognized in time. Failures there were many failures, not only in cases seen too late, but also possibly from imperfect judgment and technique. Yet here are the successful instances of which all of us have a goodly number. These are the cases to stress in our endeavor to prove that, taken in time, cancer is curable.

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¹Presented in the symposium, Cancer Is Curable, before the Clinical Congress of the American College of Surgeons, Boston, October 17, 1934.

PRIMARY CANCER OF THE VULVA, VAGINA AND FEMALE URETHRA FIVE YEAR RESULTS¹

FREDERICK J. TAUSSIG M.D., F.A.C.S., St. Louis, Missouri

BEFORE proceeding to the body of this paper, may I continue briefly the 5 year statistics on cervical cancer reported at the Congress last year from the Barnard Free Skin and Cancer Hospital where Dr. Gellhorn and I have worked in alternate services for the past 28 years. To the 64 cures out of 566 cases (a per centage of 11.3) can be added 52 cases from the year 1928-29, with 12 cures. This makes a total of 615 cases with 75 cures, thus increasing the total percentage of cures to 12.3. Our operative results have been so much better than our radium results on early cases that I wish to endorse Dr. Gellhorn's statement of last year urging the retention of surgery in our armamentarium for the treatment of cervical cancer.

Primary cancer of the vagina is very rare and almost universally fatal. Out of a total of 27 cases which were observed previous to October 1929, at the Barnard Free Skin and Cancer Hospital, only 2 survived for more than 5 years, both were early cases treated with radium. This makes the percentage of cures only 7.5. Many were too far advanced for treatment or refused treatment, so that radiation was used in only 18 cases. We acknowledge our total inability to do anything effective for primary cancer of the vagina. Radical operation was done in one recent case with prompt recurrence.

Cancer of the female urethra is somewhat more encouraging. Taking only the 5 year cases at the Barnard Hospital and including 3 of my private cases I can report 14 patients with urethral carcinomata, of whom 4 survived the 5 year period of observation. Of these 4 cured cases, 1 is living and well now for 11 years, 1 died of heart disease at the age of 84, 11 years after treatment, 1 died of breast cancer 8 years later without local

recurrence, and 1 is living and well 5 years after operation. From Table I it will be noted the best results were obtained by local excision or radiation combined with the double-Basset operation for removal of the tributary glands.

At present I prefer to treat the urethra with radium or radon seeds, rather than attempt radical excision which is so often followed by recurrence of urine. In all favorable cases, radiation is combined with the Basset operation for removal of tributary inguinal and femoral glands. Of 5 cases thus far operated on by this method there has been no fatality and only 1 recurrence.

This method of radical lymph gland removal is of even greater value in the treatment of carcinoma of the vulva. From 1906 to the present time I have seen 101 cases of vulvar carcinoma. Of these 77 were seen previous to 1929. Out of these 77 cases 10 were early and less advanced than they were at the time of treatment. Of the remaining 67 cases there were 20 five year cures and 26 per cent, representing 33.3 per cent of the treated cases. Most interesting of the results of various methods shown in Table II.

In spite of the fact that 47 patients with cancer of the vulva were seen between 60 and 70 years of age in the past 15 years, a radical lymph gland resection of the vulva and urethra. Out of

ling bladder been introduced of therapy dividing the the bladder treated as epithelioma. In these 50 results with have been cured. However, the carcinomata with the wall, and the nodular by various this symptom epithelial not one of the. A variety applied to these

TABLE I.—CANCER OF THE FEMALE URETHRA 1906-1929

Total cases: 14 Total 5 year cures: 4, 28.5 per cent			
Treatment	Number	Died	Cured (5 years)
Radiation	8	7	
Local operation	1	1	0
Local excision or radiation with Basset gland removal	3	0	3
Untreated	2	2	0
Total	14	10	4

TABLE II.—CARCINOMA

Total cases: 77 Total 5 year cures: 20, 26 per cent	
Treatment	Total
Untreated	30
Radiation only	36
Simple vulvectomy with or without radiation	10
Vulvectomy with superficial or deep gland removal	4
Vulvectomy with double-Basset gland removal	1
Total	77

¹Presented in the symposium, Cancer Is Curable, before the Clinical Congress of the American College of Surgeons, October 17, 1934.

including vulvectomyes, there were only 2 post operative deaths (5.2 per cent), 1 death on the eighth day from heart failure and 1 on the twelfth day from cerebral embolism (Table III). In spite of many cases of infected wounds there were no deaths from sepsis. No fatalities from hemorrhage or operative shock were noted in this series, in spite of the long operations and proximity to the large vessels of the groin. I consider the Basset lymph gland resection a safe operation provided the surgeon has had a little training for it. My modification of Basset's original technique has been fully described in Curtis *Obstetrics and Gynecology* (Vol. 2). The essential features of this operation consist of laying open the entire inguinal canal, ligating the deep epigastric vessels and removing the deep glands situated to either side of the external iliac vessels. Then the superficial inguinal and femoral glands are freed en masse including all tissue and glands in Scarpa's triangle up to the femoral ring. By cutting Poupart's ligament better access is often obtained for the removal of the gland of Cloquet which is situated deeply beside the femoral vessels.

This operation is by no means limited to early cancers of the vulva. The contra indications are only (1) extension to the vagina (2) large lymph glands adherent to the femoral vessels (3) extreme old age or debility. In the last named group a simple vulvectomy must suffice. Counting only the cases on my own service seen in the past 10 years, I have done a complete Basset and vulvectomy on 24 out of 34 cases, an operability of over 70 per cent. In 2 additional cases a Basset was begun but could not be completed because of densely adherent lymph glands. It is evident therefore that I have not been selecting early cases. Assuredly it is encouraging if with an

TABLE III—BASSET OPERATION

	Total cases (1904-1924)			5 year cases (1904-1924 Oct.)		
	Number	Operative deaths	Cancer in glands	Number	Cancer in lymph glands	% all over 5 years
Carcinoma of urethra	3			2		2
Carcinoma of vulva	33		8	9	1	
Total	36	(1.7%)	8	11	1	2

operability of 70 per cent I have succeeded in obtaining 5 year cures in over 63 per cent.

The rationale of this method of treating cancer of the vulva is further supported by the microscopic examination of the removed lymph glands. Out of the 19 Basset operations done over 5 years ago cancer was found present in the lymph glands 13 times and yet in 6 of these there was no recurrence during the 5 year period. All of the 6 earlier cases without detectable gland involvement remained free of recurrence. Including the 14 cases of Basset operation done since 1929 we have a total of 33 with cancer present in the tributary lymph glands 22 times, or exactly two-thirds of the cases. The failure of X ray or radium to produce more than temporary regressions in such cancerous glands has been amply demonstrated by past experiences. Radical surgical gland removal, therefore, would seem to be positively indicated except in the presence of definite operative contra indications. Finally I should like to stress that absence of palpable glands does not mean absence of cancer any more than the presence of numerous large hard lymph nodes necessarily signifies that these contain cancer metastases.

SOME REMARKS ON FIVE YEAR CURES IN MALIGNANT TUMORS¹

EDWIN BEER, M.D., F.A.C.S. NEW YORK, NEW YORK

ALTHOUGH there is no doubt that various types of malignant tumors can be surgically removed and the host survive without any evidence of local or distant recurrence, it is impossible to be sure that the patient is not harboring an unrecognizable deposit. The peculiarities in the biology of malignant cells—whether they arise from normal cells by a process of localized natural selection or by mutation—are not sufficiently well understood to help us in determining when a patient is really cured. No test for the presence of residual growth is known, except possibly the prolan determination in testicular neoplasms and chorio-epithelioma. There is no doubt that secondary and even local deposits of cancer cells remain dormant for years, only to spring suddenly into active growth and lead to a fatal outcome. Years ago S. Olbert² reported such a striking dormancy in a melanosisarcoma of the choroid, which was treated by enucleation. Twenty four years later the patient developed signs of myelitis and at autopsy showed melanosisarcoma of lungs, heart, liver and first dorsal vertebra. All of us have seen analogous cases even though the period of dormancy may not have been so long.

As yet we do not know whether this peculiar behavior is intrinsic in the cancer cells or whether it is due to some inhibitive influence exerted by the host. Moreover in these unusual cases, we do not know what the life history would have been if the original growth had not been removed, though clinical experience suggests that as a practical proposition excision of the primary deposit should be axiomatic.

Having acted on this axiom many years ago, during recent months I have seen or heard from a number of patients that are well after radical operations for a variety of malignant conditions:

1 A Wilms tumor of the kidney in an adult, 19 years after operation

2 A colloid carcinoma of the stomach, 15 years after operation

3 A carcinoma of the rectum 12 years after operation,

4 A carcinoma of the testis 17 years after operation

5 A carcinoma of the breast, 14 years after operation,

6 A number of cases of infiltrating carcinoma of the bladder, 11 to 13 years after operation

7 A carcinoma of the tongue, 15 years after the first operation.

I have been asked to furnish this symposium with my results especially in bladder and kidney neoplasms and have recently reviewed the 5 year cures for this occasion. What the exact value of a review and enumeration of disconnected cases is, I cannot quite grasp. We know that we can cure a certain number of carcinoma cases. The patient however, wishes to know what his chance of a 5 year cure is, and there we are likely to stumble. In the individual case, despite studies in microscopical grading and microscopical determination of radio sensitivity it is practically impossible to tell the individual patient what his chances are, even if we are lucky enough to get the case early. In general we can say that the earlier we get the cases, the better the outlook, and therefore the profession should aim at early diagnosis. Even advanced cases however, may be cured, and should be given the chance. A valuable contribution would be the determination of the percentage of cases in certain groups as they come to operation, that are cured for 5 years or more, rather than an enumeration of so many individual cases of a type of malignancy cured for 5 years or more by one or more surgeons. In my subsequent analysis, I have attempted this.

As a result of attempts at grading bladder tumors, considerable confusion has been introduced into the study of end results of therapy. I can see no adequate excuse for so dividing the epithelial growths developing in the bladder that benign papillomata are interpreted as epithelial carcinomata Grade I, and in this report I have excluded all such papillomata, representing some 248 cases from my discussion. In these so called Grade I carcinomata, my results with transurethral electrocoagulation have been curative in the great majority of cases. However, the results obtained in papillary carcinomata, with and without infiltration of the bladder wall, and solid carcinomata, infiltrating ulcerating nodular and more or less papillary, treated by various forms of therapy, fit properly into this symposium. These cases represent the real epithelial malignancies of the bladder, and present one of the major urological problems of the day. A variety of therapeutical efforts has been applied to these

² *Zentralbl. f. Chir.*, 1906, p. 509

¹ Presented in the symposium, Cancer I. Carable before the Clinical Congress of the American College of Surgeons, Boston, October 27, 1924.

cases, and limiting myself to cases treated or operated upon prior to 1930 I find that we have the following results:

1. Non-infiltrating carcinomata, 11 cases cured by transurethral fulguration or electrocoagulation with high frequency current, representing 55 per cent of total so treated and not lost to follow-up.

2. Non-infiltrating or moderately infiltrating, papillary carcinomata, 4 cases cured by transurethral radium, usually with electrocoagulation, representing 11 per cent of the total so treated and not lost to follow up.

3. Infiltrating papillary carcinomata involving the bladder wall more or less diffusely 10 cases cured by operative excision according to the technique described by me in 1917^{1,2,3} representing 55.5 per cent of the total so treated and surviving the operation and not lost to follow-up.

4. Infiltrating, solid, ulcerating, more or less papillary carcinomata, diffusely involving the bladder wall, 14 cases cured by extensive resections, frequently with re-implantation of the ureter according to the above mentioned technique, representing 40 per cent of the total so treated and surviving the operation and not lost to follow-up.

5. Infiltrating solid, ulcerating more or less papillary carcinomata diffusely involving the bladder wall, 3 cases cured by suprapubic cystostomy and implantation of radium emanation seeds, representing 10 per cent of the total so treated and surviving the operation and not lost to follow-up.

6. *Very extensive*, solid, ulcerating more or less papillary carcinomata, diffusely involving the bladder wall, 4 cases cured by total cystectomy representing 57 per cent of the total so treated and surviving the operation.

With cauterization, diathermy or electric cautery or Paquelin cautery and deep X ray there have been no 5 year cures in carcinomata infiltrating more or less diffusely the bladder wall.

In summary therefore, in these 6 groups of definite carcinomata, I can report 45 cures in

cases treated prior to 1930. It must be borne in mind that owing to the advanced age of many of these patients when they present themselves for treatment, their life expectancy scarcely warrants a 5 year survival, and many more cases were apparently cured in each category for periods of less than 5 years, but sufficiently long to consider cured.

The results in kidney malignancies must be divided into two categories, (1) the hypernephromata or clear cell carcinomata, the adenocarcinomata, the papillary and squamous cell carcinomata in adults, and (2) the embryomata, Wilms tumors and sarcomata usually seen in childhood.

In children prior to 1930 in Wilms tumors or embryomata we have no 5 year cures. It is hoped that pre-operative radiation followed by nephrectomy may improve our results. One case of hypernephroma in a child, however was cured for over 5 years, giving in this group of 7 nephrectomies only 14.66 per cent cures. In view of the fact that all kidney tumors in children are not necessarily embryomata and in view of the fact that embryomata may vary in their malignancy the operative removal of such tumors should be regularly carried out.

In adults prior to 1930, we have 7 five year cures in kidney tumors of the hypernephroma and adenocarcinoma and papillary carcinoma type, 1 five year cure in a large embryoma or Wilms tumor and 1 five year cure in a carcinoma of the ureter or 9 cases in all out of 34 surviving the operation and followed, making 26 per cent plus.

In concluding it must be emphasized that in view of the fact that the postoperative follow-up of the whole series of kidney tumors has been incomplete, the percentage of 5 year cures based on survival after operation and 5 year follow-up may represent a maximum percentage of cures whereas in bladder tumors, when repeated cystoscopic check up (usually disagreeable to the patient) is possible, it probably represents a minimum percentage of cures. These patients after several negative cystoscopies tend to be chary and refuse check up (and this applies to doctors as well as other patients) in this way diminishing the number of 5 year cures.

¹Burg. Gynec. & Obst. 1917 34 645-647 (Read at the Chemical Congress of Surgeons of North America, Philadelphia, October 1-10, 1916)

²J. Am. M. Ass. 1917 68 680-68

³Ann. Surg. 1917, 71 72-76

FIVE YEAR CURES OF CANCER OF THE RECTUM BY THE RADICAL ABDOMINOPERINEAL EXCISION¹

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THE cure of cancer of the rectum depends upon three main factors (1) the knowledge of the pathological paths along which the growth spreads, (2) the planning of an operation to include as much as possible of the fields of spread, (3) careful pre-operative, operative, and postoperative treatment.

1 The way in which cancer of the rectum spreads is too well known to need repetition here, except to remind ourselves that it occurs (a) in a downward direction to the ischio-rectal fossa, (b) in a lateral direction on the levatores ani muscles, and (c) most important of all, in an upward direction along the course of the inferior mesenteric artery, and thence laterally toward the wall of the pelvic colon.

2 Three main principles of surgery are involved in operating upon cancer of the rectum (1) Not only the growth but also all removable fields of lymphatic spread must be extirpated as widely as possible. In this instance the upward spread demands the most careful attention, and should be removed just up to the point where the left colic artery arises from the inferior mesenteric artery (2) Where an operation involves two different fields of maneuvers of which one is sterile and the other relatively infected, the aseptic field should first be dealt with and closed off, and the infected area should be dealt with last, in order that the former may not be infected from it. (3) Before a primary growth is tampered with or manipulated in any way the blood and lymph vessels, which are liable to transmit metastatic cells into the venous and lymphatic circulations, should be ligated. Primary dissection should be carried out as far as possible from the original growth.

The only operation which fulfils these fundamental principles is the radical abdominoperineal excision introduced in 1907 by my friend and senior colleague, Mr W. Ernest Miles.

3 *Pre-operative, operative and postoperative treatment.* In the pre-operative treatment, the following measures are followed (1) Care is taken to ensure that the patient's general health, blood pressure, pulse pressure and cardiac index, together with renal and other vital functions, are satisfactory (2) Dehydration is combated and

no purgation is allowed for 48 hours before operation. (3) Careful attention is paid to the state of the patient's bowels and any suspicion of obstruction is treated by performing a cæcostomy or colostomy some days before the radical operation in other cases a 5 to 7 day course of careful colon wash-outs is carried out. (4) Any lack of hæmoglobin or erythrocytes is combated by a preliminary blood transfusion (5) Careful premedication is used—my routine is two-thirds grain pantopon and 1/510 grain scopolamine one hour beforehand.

In the operative treatment during operation we find that the use of a spinal injection of 1-1500 percaïne markedly diminishes shock. Ether and chloroform are rigorously excluded, and nitrous oxide oxygen is employed as the general anæsthetic.

About 10 years ago I introduced a blood transfusion as a regular routine postoperative practice for all cases, and for the last 2 years have, in addition, been giving continuous intravenous infusion with glucose-saline for the first 24 hours, and sometimes longer, after the operation and meanwhile all fluids by mouth are withheld.

In my opinion the most important new lines in technique have been (1) the routine use of spinal anæsthesia, (2) the employment of nitrous oxide oxygen (3) careful pre-operative care of the intestine, (4) pre-operative building up of natural reserves, (5) absolute aseptic intestinal division, (6) presacral neurectomy, and the avoidance of urinary infection, (7) immediate routine post-operative blood transfusion, (8) continuous intravenous glucose saline infusion. These measures have had a definite influence upon the mortality of the operation, which is steadily improving.

Five year cures. I have the honor to report on 164 survivals after this operation, operated on by the staff of the Cancer Hospital, London, during the 10 year period 1920 to 1929 inclusive.

You have asked me to analyze my cases on a pathological basis and under the following headings (1) incipient, cancer (localized) without gland involvement, (2) cancer that has extended to the lymph nodes (3) extensive local invasion with metastases (4) recurrent cancer.

As this type of growth in Group 4 is not suitable

for the operation it has perforce to be omitted. In 70 of the total series the exact pathological condition is known. These are analyzed in Table I.

TABLE I

	Group	No.	Died in less than 5 years	Alive and well after 5 years	Untraced	Percent age of 5 year cures
Rectovesical	I	6		5		83
	II	3				33
	III	8	7			14
Vaginal	I			16		79
	II	9		5		79
	III	8	6			14
Anal canal	I					89
	II					
	III					
Totals, here pathological condition is known		70		5	53	5

From this the following facts emerge. Early cases without glandular involvement have on the whole a higher 5 year cure rate than the more extensive ones. In the central portion of the

rectum this radical operation is as efficacious in effecting a 5 year cure in those with lymph nodes involved as in those in which lymphatic invasion cannot be demonstrated pathologically.

Of the total series of 164 survivals, 47 cases died within 5 years of the operation, 104 were alive and well 5 years and more after and 14 are untraced.

TABLE II—COMPLETE SERIES

Survivals	164
Died in less than 5 years	47
Alive and well after 5 years	104
Untraced	14
Percentage of 5 year cures	63.4

Out of all survivals 63.4 per cent were known to be alive and free from signs of the disease 5 years after the operation. If the untraced cases are ignored 104 out of 150 cases traced represent a 5 year cure rate of 69.3 per cent.

I have to express my thanks to my colleagues the Staff of the Cancer Hospital, for their kindness in placing their material at my disposal. I also wish to convey to you and the Board of Regents of this illustrious College my heartiest and humblest thanks for the great honor you have done me in asking me to present the results of our work to you today.

MALIGNANT DISEASES OF THE MOUTH, PHARYNX AND LARYNX
FIVE YEAR CURES¹GORDON B NEW M.D. F.A.C.S., AND FREDERICK A. FIGI, M.D., F.A.C.S. ROCHESTER, MINNESOTA
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WE are reporting 745 cases of malignant disease of the mouth, pharynx and larynx, in which patients have survived 5 or more years without recurrence. Treatment in these cases has been by surgical operation surgical diathermy and radiation, depending on previous treatment, situation of the lesion, type of growth presence or absence of involvement of lymph nodes, and the patient's age and general condition.

Patients surviving 5 years or more after treatment of a malignant growth of the upper jaw and antrum numbered 127 (2). The primary tumors of the antrum are those that apparently originate in the antrum itself the secondary tumors of the antrum are those that originate apparently in the upper jaw and extend into the antrum. The tumors of the upper jaw and palate are those which are situated in the regions named without involving the antrum. Growths were destroyed by surgical diathermy and irradiation applied either through the mouth or after lateral rhinotomy. The end results in this group of cases are shown in Table I.

Patients surviving 5 or more years after operation for carcinoma of the lower jaw numbered 90. In these cases the growth was destroyed by surgical diathermy and the submental and submaxillary lymph nodes were removed, if the mucous membrane of the cheek or floor of the mouth was involved. In addition to this, radiation was used both locally and externally over the lymph nodes of the neck in the indicated cases. The end-results in these cases are given in Table II.

TABLE I—MALIGNANT GROWTHS OF UPPER JAW AND ANTRUM 127 PATIENTS SURVIVING 5 OR MORE YEARS AFTER TREATMENT

Situation of growth	Patients treated	Patients traced	Lived 5 or more years after treatment	
			Number	Per cent of traced patients
Antrum, primary	91	78	30	40
Antrum, secondary	30	41	23	53.4
Upper jaw and palate	124	118	74	62.7
Total	245	236	127	53.8

Five or more years after treatment for carcinoma of the lip 357 patients operated on between 1919 and 1927 were surviving (1). In general the primary lesions are widely excised and the bilateral submental and submaxillary lymph nodes are removed. In many cases in which the primary lesions have received previous treatment it is necessary to remove the lesion by means of surgical diathermy or the cutting cautery and to delay plastic closure or reconstructive operation until there is a reasonable chance of the lesion not recurring. If a submental or submaxillary node is involved an upper deep cervical dissection is done on the involved side. Radiation is used in addition, particularly in cases in which lymph nodes are involved. The end results in this group of cases are recorded in Table III.

Patients surviving 5 or more years following treatment for carcinoma of the tongue numbered 58. The local lesion in cases of this sort is treated by means of surgical diathermy, complete removal of the lesion by cautery, insertion of radium or a combination of these, depending on the situation, extent, and type of growth. Radiation is administered by means of radium emanation seeds or radium element points introduced into the primary lesion. The lymph nodes of the neck are removed except in epitheliomata of malignancy graded IV, followed by irradiation. In Table IV are given the end results in this group of cases.

There were 44 patients surviving 5 or more years after treatment of malignant tumors of the pharynx and tonsil (3). This group does not include the nasopharyngeal tumors. Primary lesions of low grade of malignancy are removed

TABLE II.—MALIGNANT GROWTHS OF LOWER JAW 90 PATIENTS SURVIVING 5 OR MORE YEARS AFTER TREATMENT

Lymphatic involvement, cases	Patients operated on	Patients traced	Lived 5 or more years after operation	
			Number	Per cent of traced patients
Nodes involved	45	33	1	2.9
Nodes not involved	145	113	79	69.9
Total	187	145	80	54.8

TABLE III.—EPITHELIOMA OF THE LIP 337 PATIENTS SURVIVING 5 OR MORE YEARS AFTER TREATMENT

	Lived 5 or more years after operation			
Lymphatic involvement, cases	Patients operated on	Patients traced	Number	Per cent of traced patients
Nodes not involved but dissected	225	234	19	8.1
Nodes not involved clinically and not dissected	209	196	29	14.8
Nodes involved and dissected	30	44	8	18
Total	547	75	357	75

*Nodes not dissected because of type of growth, age of patient, and so forth.

TABLE IV.—EPITHELIOMA OF THE TONGUE 58 PATIENTS SURVIVING 5 OR MORE YEARS AFTER TREATMENT

	Lived 5 or more years after operation			
Lymphatic involvement, cases	Patients operated on	Patients traced	Number	Per cent of traced patients
Nodes not involved but dissected	30	52	29	55
Nodes not involved clinically and not dissected	20	54	19	35
Nodes involved and dissected	17	25	8	32
Extensive to floor of mouth	6	6	3	50
Total	6	36	58	100

*Cases in which there was extensive to the floor of the mouth not included.

†Nodes not dissected because of type of growth, age of patient, and so forth.

with the cutting cautery or by diathermy and this is followed by removal of nodes of the neck. For lesions of a high grade of malignancy and for lymphosarcomata, radiation is applied by introducing the agent directly into the primary lesion and placing it externally on the neck. For adenocarcinomata of mixed tumor type, the tumor is removed through the pharynx or the side of the neck, depending on where the largest portion presents. In Table V are shown the end-results in this group of cases.

Five or more years after operation, 69 patients who had carcinoma of the larynx were surviving (4). For tumors of low grades of malignancy and in early cases, we perform thyrotomy and remove the growth, destroying the base of it by surgical diathermy. In more advanced cases, the cartilage is removed along with the growth. In a small

TABLE V.—MALIGNANT GROWTHS OF THE PHARYNX AND TONSIL 44 PATIENTS SURVIVING 5 OR MORE YEARS AFTER TREATMENT

	Lived 5 or more years after operation		
Pathological type	Patients traced	Number	Per cent of traced patients
Squamous cell epithelioma	34	9	26
Lymphosarcoma	11	6	54
Adenocarcinoma, mixed tumor type	3	20	93
Total	75	44	57

TABLE VI.—CARCINOMA OF THE LARYNX 69 PATIENTS SURVIVING 5 OR MORE YEARS AFTER OPERATION

	Lived 5 or more years after operation		
Operation	Patients traced	Number	Per cent of traced patients
Thyrotomy	34	5	14
Laryngectomy	73	4	5
Total	107	69	64

group of cases in which the anterior commissure is involved, this is removed in one piece, after division of the hyoid bone and examination is made through the thyrohyoid membrane. For growths of the epiglottis preliminary tracheotomy is performed, and the primary lesion is removed by surgical diathermy under suspension. In more advanced cases of tumor of the epiglottis, aryepiglottic fold, and base of the tongue, pharyngotomy is used. In cases in which there is fixation of one side of the larynx, with involvement of the anterior commissure, and the lesion is of a high grade of malignancy, laryngectomy is performed. Radiation is used before and after treatment of the more malignant lesions. The end-results in these cases are shown in Table VI.

BIBLIOGRAPHY

1. Frost, F. A. Epithelioma of the lower lip: results of treatment. *Surg. Gynec. & Obst.*, 1934, 59:810-819.
2. New, G. B. and CAMOT, CLYDE. Curability of malignant tumors of the upper jaw and antrum. *Surg. Gynec. & Obst.* (In press).
3. New, G. B. and CHILDS, J. H. Tumors of the tonsil and pharynx (three hundred fifty-seven cases). *Arch. Otolaryngol.*, 1931, 14: 596-600.
4. New, G. B. and WADON, J. M. The curability of carcinoma of the larynx. *Surg. Gynec. & Obst.*, 1934, 58, 841-844.

FIVE YEAR SURVIVALS IN LYMPHATIC TUMORS¹

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FIVE year survivals following treatment of Hodgkin's disease, lymphosarcoma, and leucæmia by irradiation are few. Some writers doubt that the average duration of life following onset of these diseases can be increased by the use of X rays or radium. This question cannot readily be answered by statistics, largely because the great variations in duration of the natural course impair the value of averages.

However, the dramatic primary regressions, and the lessening or disappearance of symptoms that are brought about by irradiation in numerous individual cases, suggest that life has been prolonged in these instances, at least, and fully justify the continued use of X rays and radium in these fields.

The following four tables show the 5 year survivals in cases of Hodgkin's disease, lympho-

sarcoma, myeloid leucæmia and lymphatic leucæmia admitted to Memorial Hospital between 1917 and July 1 1929.

What can be done to improve these figures? In this entire group betterment of the patients' living conditions approaching a general régime as for tuberculosis will help to prolong survival. The various adjuvants, such as heliotherapy, arsenic, iron, liver, transfusions, and surgical removal of localized processes, cannot be discussed here.

As for the results by irradiation alone early diagnosis, except in the naturally acute forms of the diseases, with early judicious treatment, not necessarily heavy irradiation, will improve our figures.

TABLE I.—HODGKIN'S DISEASE—FIVE YEAR SURVIVALS

	Number	Per cent	Average survival since admission—years
All cases	115	100	1.9 (excluding 4 cases followed less than 6 months)
Total 5 year survivals	15	13	7.5
Alive 5 years on 7-1-34	6	4.8	8.9
Alive 5 years and N.E.D. on 7-1-34	4	3.5	10.5

6 survived over 7 years.
Longest survival 13 1/2 years, now N.E.D. Rooper lymphogranulosa maligna with much fibrosis.
No evidence of disease.

TABLE II.—LYMPHOSARCOMA—FIVE YEAR SURVIVALS

	Number	Per cent	Average survival since admission—years
All cases	95	100	1.4
Total 5 year survivals	7	7	7.35
Alive 5 years on 7-1-34	3	3	6.9
Alive 5 years and N.E.D. 7-1-34	3	3	7.8

Longest case 10 1/2 years

TABLE III.—MYELOID LEUCÆMIA—FIVE YEAR SURVIVALS

Excluding cases untreated or lost to follow-up within 6 months

	Number	Per cent	Average survival since admission—years
All cases	68	100	1
Total 5 year survivals	4	5.9	6
Alive 5 years on 7-1-34	0	0	
Alive 5 years and N.E.D. on 7-1-34	0	0	

Longest case 7 1/2 years

TABLE IV.—LYMPHATIC LEUCÆMIA—FIVE YEAR SURVIVALS

Excluding cases untreated or lost to follow-up within 6 months

	Number	Per cent	Average survival since admission—years
All cases	17	100	1.9
Total 5 year survivals	7	9	7.5
Alive 5 years on 7-1-34	3	3.5	6.5
Alive 5 years and N.E.D. on 7-1-34	17	100	3.5

Longest cases 3 1/2, 5 1/2, and 7 years.

THE SURGICAL TREATMENT OF CANCER OF THE STOMACH¹

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ABOUT one-fourth or one third of the 120,000 deaths from cancer every year in the United States is from cancer of the stomach.

There is no real problem as to what the treatment of gastric cancer should be. Practically all malignant tumors of the stomach, except the rare lymphosarcoma and the unusual small round cell carcinoma from the deeper layers of the mucosa, are radioresistant. With improvement in the technique of radiation doubtless some further beneficial effect can be derived from this source but with the liver overlying the stomach and the pancreas behind it, an amount of radiation that would materially affect a gastric cancer that is even mildly radioresistant would doubtless play havoc with these two vital organs. We may say then that while in some instances radiation is an adjuvant, in the vast majority of cases of cancer of the stomach there is only one remedy—surgical excision, which is remarkably efficient if applied early. Thus Balfour reports that in his records about 50 per cent of the patients in whom gastric carcinoma confined solely to the walls of the stomach has been widely removed are alive and without recurrence 5 years after operation.

CLASSIFICATION OF OPERATIONS FOR GASTRIC CANCER

The surgical therapeutics for cancer of the stomach may be divided into 6 different classes, 3 of them with a view to cure, and 3 solely for palliation. The Billroth I operation, the Billroth II operation and total gastrectomy may be listed as curative operations while gastro-enterostomy, the Devine operation, and gastrostomy are only palliative.

In the first division is cancer of the pyloric end of the stomach in which it is possible to do a reasonably wide resection and then unite the stump of the stomach to the duodenum. Operations which proceed along this line are classified under the title of the Billroth I method, and the various techniques such as the Finney-Haberer and others that accomplish this are termed modifications of the Billroth I.

In the second division are the more extensive cancers of the pyloric portion or of the middle body of the stomach in which it is not possible to bring the stump of the stomach to the duodenum so the duodenum must be closed and an anasto-

mosis made to some portion of the jejunum. This is known as the Billroth II method of operation and the various types of it as the Pölya-Hofmeister and Balfour techniques, are called modifications of the Billroth II principle.

In the third division, the stomach is extensively involved without surrounding metastases, or the cardiac portion is affected, and here a total gastrectomy may be indicated. This operation of course, is applicable to only a comparatively small number of cases.

In certain non-resectable cases of gastric cancer often some palliative operation is indicated. It is doubtful if gastro-enterostomy has any place in the treatment of cancer of the stomach. It certainly has a very limited field, which is apparently vanishing. If the patient has a large mass in the pyloric end of the stomach and there are a few metastases outside of the stomach or a small metastasis in the liver doubtless a partial gastrectomy removing the sloughing septic mass, will make the patient more comfortable and probably give a longer life than a gastro-enterostomy would.

PREPARATION, ANESTHESIA AND AFTER TREATMENT

The pre-operative and postoperative treatment in all cases of cancer of the stomach is extremely important. Several times a day the patient should have a gastric lavage under low pressure. Dehydration is corrected largely by proctoclysis, hypodermoclysis or the intravenous administration of dextrose in Ringer's solution which latter procedure we have found particularly satisfactory. Transfusion of blood is often indicated.

Following the suggestion of W. H. Higgins, of the staff of St. Elizabeth's Hospital we began about 10 years ago giving patients who were to be operated upon for gastric cancer large quantities of dilute hydrochloric acid for several days before the operation. This has a marked antiseptic effect and lessens the danger of peritonitis. Some intraperitoneal vaccine such as that of Steinberg may also be helpful in preventing infection.

The anesthetic should be carefully chosen. In many cases operations for gastric cancer can be done under local anesthesia, supplemented if necessary by ethylene or by nitrous oxide and

¹Presented at the 25th session, on the Treatment of Cancer, before the Clinical Congress of the American College of Surgeons, Boston, October 17, 1934.

oxygen, and frequently if morphine and scopolamine are given it can be completed under a local anæsthetic, infiltrating just beneath the peritoneum after the method of Finsterer

MODIFICATION OF BILLROTH I OPERATION

I shall not attempt to describe all of the different operations for cancer of the stomach, but shall only give those that appear to me to be the most satisfactory. Some modification of the Billroth I technique can be applied more frequently than it is used, but metastases of gastric cancer are prone to extend along the lesser curvature of the stomach, and an attempt to make a satisfactory approximation of the stomach to the duodenum should not prevent a sufficiently wide excision. The point of resection should be at least 4 centimeters beyond the apparent margin of the cancer. If more of the stomach than this can be removed without impairing the conditions for the operation, it should be done. The first procedure after opening the peritoneal cavity, is inspection of the abdominal contents, feeling in the pelvis for metastases in the cul-de-sac, and examining the liver and the lymph nodes under the diaphragm. If there is no contra indication for a radical operation and a Billroth I type of operation is applicable, the gastrohepatic omentum is opened. If the operation is done under local anæsthesia, the tissue just beneath the posterior peritoneum above the pancreas and up toward the diaphragm on both sides of the spinal column are thoroughly infiltrated with 0.5 per cent novocain solution to which has been added about 2 drops of 1:1000 adrenalin solution to the ounce. If the needle is inserted just under the peritoneum no damage to the deeper structures will occur and the solution will infiltrate freely and block off all of the nerves in the region.

The vessels along the lesser curvature of the stomach at the proposed point of resection are doubly clamped and divided preferably with the electric cautery. The gastrohepatic omentum, which is usually quite thin, is doubly clamped and divided about its center and the vessels to the pyloric end of the stomach are similarly treated being divided with the electric cautery. The stomach is lifted up, making all movements as gentle as possible, not only to prevent shock but to avoid transplanting cancer cells. Gauze moistened with salt solution is placed in the lesser peritoneal cavity. The stomach is lifted up with the hand, and with the fingers the gastrocolic omentum is pushed up. The proper point of division along the lower border of the stomach is selected, the gastrocolic omentum is incised, and

the vessels are doubly clamped and divided at the greater curvature. Then the gastrocolic omentum is doubly clamped and divided in sections toward the pyloric end of the stomach, keeping close to the colon. When the pyloric end of the stomach is reached special care is taken to avoid injury of the mesenteric vessels of the transverse colon. By lifting the stomach well up in this region and by separating any adhesions and pushing down the transverse mesocolon injury to its vessels can usually be avoided, but it is highly important to remove as much tissue as possible from around the pyloric end of the stomach.

The blood vessels are controlled by transfixing and tying each clamped segment with plain catgut. The ends of some of these ligatures are left long. Two ligatures are placed on the stump of the vessels along the lesser curvature, and the one nearest the point of division is left long. This is to avoid the possibility of the ligature in this region slipping. The portion of the stomach to be resected is thus isolated entirely, except for its continuity with the rest of the stomach and with the duodenum. Two stout Payr clamps are placed on the body of the stomach as close together as possible. Two clamps preferably pedicle clamps such as the Ochsner or Kelly forceps, are placed on the duodenum just beyond the pylorus. The duodenum is divided between the clamps with the electric cautery, and then the stomach is incised between the two Payr clamps with the electric cautery, taking care to cauterize the stump of the stomach thoroughly so that the Payr clamp is heated sufficiently to char the tissues within its grasp. This not only kills any cancer cells that may be in the grasp of the clamp and so adds somewhat to the chances of cure, but also tends to control bleeding. The stump of the stomach is brought over to the stump of the duodenum. If there is not sufficient undersurface of the duodenum exposed the pancreas is dissected back, preferably with a few light strokes of the electric cautery.

In many instances when the stump of the stomach apparently cannot be brought over to the duodenum, the stomach may be mobilized by slipping the hand under the cardiac end, stretching or dividing any adherent bands, and dividing the gastric artery if necessary. Often these manipulations will be so effective that even a small remnant of stomach which at first it seems impossible to bring over can be mobilized and sutured to the duodenum without tension.

Beginning at the upper border, a series of interrupted mattress sutures of 00 tanned or chromic

catgut is placed uniting the posterior surface of the stump of the duodenum to the upper portion of the posterior surface of the stump of the stomach. All of these sutures are placed before any one is tied (Fig. 1). When they are tied the ends of the upper and of the lower sutures are left long as tractor sutures. The clamp is removed from the stump of the duodenum and any regurgitant duodenal content is removed with a suction apparatus. Bleeding vessels are clamped with small hemostats. The Payr clamp on the stump of the stomach is removed, bleeding points are clamped and the gastric contents are withdrawn with a suction apparatus. The stomach of course, should have been washed out a short while before the operation. Occasionally in marked pyloric obstruction gastric lavage will not remove all of the contents of the stomach in some cases I have found food, such as corn or beans, that was eaten several days before. If it is suspected that this may occur there is placed among the instruments a small soup ladle, with which the contents of the stomach can be ladled out, after which the stomach is cleaned with salt solution. If the surrounding tissues are well protected with moist gauze, and care is used in the ladding, but little soiling occurs, and if abundant hydrochloric acid has been given for several days before the operation this material should not be very septic.

No effort is made to trim away the margins of the crushed tissue. A study of the sutured intestine and stomach shows that the margin of the wound always degenerates and tissue that is held by sutures firmly enough to produce complete hemostasis will slough off so that trimming away the margins of crushed or charred tissue is of no advantage so far as eventual healing is concerned, causes an additional loss of blood, and unnecessarily exposes fresh surfaces to the contents of the stomach and duodenum.

A suture of No. 1 tanned or chromic catgut is begun, going from the mucous membrane on the upper border of the stump of the stomach outward, returning through the upper border of the stump of the duodenum from without inward. This knot is tied several times, and the short end is clamped. If the stump of the stomach is large its lower portion is clamped with a pedicle forceps. This suture is continued downward as a lock stitch, snugly uniting the posterior margin of the stump of the stomach to the posterior margin of the stump of the duodenum (Fig. 2). When the lower border of the duodenum is reached, its anterior wall is incised for $1\frac{1}{4}$ to $1\frac{3}{4}$ inches (3 to 4 cm.) This incision should be just below the center of the anterior surface of the duodenum,

and its location is accurately ascertained by putting the finger into the duodenum. This incision flares open the duodenum and permits about two more stitches of the continuous lock stitch, uniting the stomach to the duodenum. Then the suture is continued over the redundant lower portion of the gastric stump and tied at the greater curvature (Fig. 3). Occasionally by flaring open the duodenum thus, if the stomach is not large, an end-to-end union can be made but usually there is a redundancy of the stump.

A second suture is begun as the first suture, passing from within outward at the lesser curvature of the stomach and from without inward at the upper border of the duodenum. After tying this suture, its short end is tied several times to the short end of the preceding suture. This makes for additional security. This suture is carried anteriorly as a continuous stitch. Where there are bleeding vessels, an additional loop of the stitch is taken to secure hemostasis. The suture is placed as far as possible from within, being tightened only on the left side as it emerges from the stump of the duodenum while pressure is made just behind it, as shown in the illustration. In this way not only is hemostasis secured, which cannot be satisfactorily done by the continuous mattress suture, but the raw margins are inverted almost as though the suture were applied entirely from within (Fig. 4). When the lower border of the duodenum is reached this suture, too, is continued onto the redundant stump of the stomach and terminates at its lower border. A suture of No. 00 tanned or chromic catgut is begun as a purse-string suture at the lower border of the stomach, invaginating the redundant test (Fig. 5). It is then carried upward, as a continuous mattress or right angle suture with an occasional backstitch, and terminates at the upper border of the stomach. At this point the ligatures on the vessels at the upper border of the duodenum and on the vessels of the lesser curvature of the stomach are tied together and over them is inserted a purse-string or a mattress suture of No. 00 tanned or chromic catgut, still further invaginating the tissues. This region is particularly subject to peristalsis and traction, and additional suturing here is advisable. At the lower border where the redundant test of stomach was tucked in, a purse-string suture of No. 00 tanned or chromic catgut is placed, and after it is tied the ends are passed through adjacent peritoneal covered fat and are again tied. A few additional interrupted sutures of No. 00 tanned or chromic catgut may be placed anteriorly and if peritoneal covered fat is handy it is also caught in the suture.

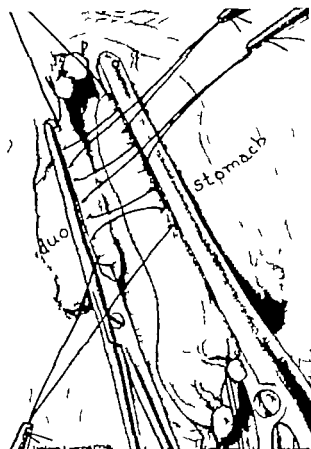


Fig. 1 The segment of the stomach has been removed. The posterior margin of the stump of the stomach is sutured to the posterior margin of the stump of the duodenum with interrupted mattress sutures of fine tanned or chromic catgut. All of the sutures are placed before any one is tied.

This operation I have been doing with much satisfaction for the past 10 years in cancer of the stomach and in ulcers of the pyloric portion of the stomach. Its advantages are that the pathological lesion is excised and the physiological function of the stomach is restored as nearly as possible to normal. The physiologically active lesser curvature of the stomach is aligned with the upper border of the duodenum which is its normal relationship. The physiologically inactive greater curvature is easily folded in. The great objection to the original Billroth I operation, the so called "deadly triangle" which occurred when the stump of the duodenum was aligned to the greater curvature of the stomach, is avoided. By invaginating the gastric stump along the greater curvature where it is quite mobile and by bringing over peritoneal covered fat, this region is made secure. Flaring open the duodenum after it has been fixed by sutures does not displace its relationship to the upper border of the stomach and at the same time gives a wide opening which prevents contraction and will doubtless be a sufficient exit for

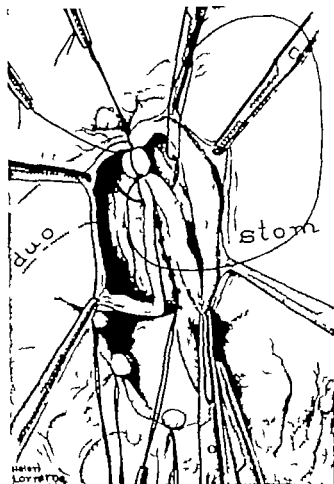


Fig. 2 The internal row of sutures is being applied uniting the posterior margin of the stump of the stomach to the posterior margin of the stump of the duodenum. The dotted line shows where the incision will be made in the duodenum to flare it open.

food even if recurrence of the cancer makes some obstruction in this region.

The field of operation is limited to the vicinity of the lesion and does not involve the possibilities of spreading bacterial infection or cancer cells to the other organs or to tissues below the transverse mesocolon, which might be possible in the types of Billroth II.

It is well known that in many cases of cancer of the stomach there is some free hydrochloric acid in the gastric juice. If there is no free hydrochloric acid at the time of operation and the patient is cured by removing the cancer it may be reasonably assumed that the secretion of hydrochloric acid will be resumed in at least some cases. Physiologists have shown that the sensitiveness of the intestinal mucosa to hydrochloric acid increases from the duodenum down, and that the duodenum normally has far more resistance to hydrochloric acid than any other portion of the intestinal tract. It is readily conceivable that what not infrequently happens in partial gas-

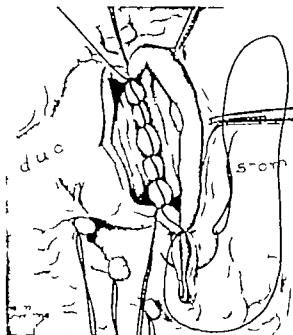


Fig 3 The duodenum has been flared open and the posterior row of sutures is about completed

treotomy for peptic ulcer in which the Billroth II type of operation is done—development of a jejunal ulcer—may occasionally occur in partial gastrectomy for cancer when the Billroth II type is done. Thus, Fordyce B St John has reported a case of death from jejunal ulcer which followed some time after a Polya type resection for cancer of the stomach.

The technique described must often be modified to suit the conditions. If for instance, there are adhesions along the head of the pancreas, it will be best to divide the stomach between the Payr clamps and dissect it toward the pyloric end preferably with the cautery and if necessary include a small portion of the pancreas in the dissection. If there seem to be adhesions and special involvement along the lesser curvature, the gastrosplenic omentum should be first opened and then the stomach can be divided between the Payr clamps, the duodenum between clamps, and finally the dissection made toward the lesser curvature.

In occasional cases the transverse colon is involved, so in order to maintain the principle of block dissection the gastrosplenic omentum is first divided in segments, the stomach doubly clamped and divided about its middle, and the duodenum also divided. The stomach is then lifted up, the mesocolon is divided in segments, and the regions for section of the transverse colon

are doubly clamped and divided with the cautery thoroughly charring the stumps. The stomach is then united to the duodenum, as has been described, and lastly, the stumps of the transverse colon are treated. The kind of treatment depends largely upon the condition of the patient. If the patient is quite fat, or if his condition is not good, it will doubtless be best to bring the stumps of the colon into the wound, leaving the clamps upon them, and to do a right colostomy through a muscle splitting incision bringing up the first portion of the ascending colon onto the abdominal wall placing a glass rod beneath it, and then opening the cecum. This procedure would probably be indicated even with a direct anastomosis of the colon, which may be advisable when the patient is thin with an empty bowel.

The type of operation described has, I think, a far larger field than has been generally credited to it. Undoubtedly however there are many cases in which the stump of the stomach cannot be satisfactorily united to the duodenum, and here some type of Billroth II operation should be done.

MODIFICATIONS OF BILLROTH II

The most popular type of Billroth II is the Polya operation, in which the jejunum is brought up through a rent in the mesocolon and sutured to the stump of the stomach as an end-to-side union. If it is possible to do so the anastomosis is drawn down through the rent in the mesocolon, so it lies below the mesocolon and resembles a posterior gastro-enterostomy.

In some instances, when this is difficult, the modification introduced by Balfour is excellent, bringing the jejunum over the colon and suturing it to the stump of the stomach. When this procedure is adopted a long loop of jejunum should be chosen because the oral end of the loop if too short swells and may cause obstruction. An entero-anastomosis should be made between the two limbs of jejunum, just below the transverse colon.

The Hofmeister modification of the Billroth II appears to me to be better than the usual Polya. In the Hofmeister operation, which is particularly applicable when the stump of the stomach is very large the upper portion of the stump is closed by sutures and the lower half or third is left open and anastomosed to the jejunum end-to-side (Fig 6). In such cases it will be less difficult to bring down the lower portion of the stump of the stomach for the anastomosis than to bring down all of it, as with the Polya operation. One objection to the Hofmeister operation is that if the incision of the

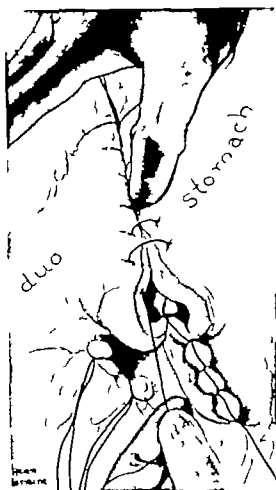


Fig. 4. The anterior row of sutures, which was begun as explained in the text, is continued downward in such a way as to invert the margins of the stomach and duodenum. The suture is drawn taut only as it emerges from the duodenal mucosa, while pressure with the thumb or finger is made on the wound behind the stitch.

gastrectomy is made in such a manner as to leave a marked redundancy along the greater curvature, infolding of the upper portion of the stump may convert the lower portion into a kind of snout and produce occlusion. To avoid this, the incision in the stomach should be made with a distinct slant from the lesser curvature downward and to the left. Even then, if there appears to be too much redundancy, the lower portion of the stump should be cut away.

TOTAL GASTRECTOMY

While total gastrectomy has a limited field this field is definite and with improvement in technique, and in the pre-operative and postoperative care of the patient, this operation will be more often indicated.

In total gastrectomy infection is more likely to occur than in partial gastrectomy, and drainage should usually be provided. In this operation the



Fig. 5. A purse-string suture of fine tanned or chromic catgut is placed at the lower portion of the stump of the stomach, inverting the redundancy.

attachments to the stomach along the greater and lesser curvatures are severed as in a partial gastrectomy. A rubber catheter is inserted at some portion of the stomach where the wall seems to be normal and fastened with a purse-string suture of linen which also transfixes the catheter. Another purse string suture buries the catheter still further (Fig 7A). The catheter is connected at intervals with a suction apparatus and so draws off gas and the fluid contents of the stomach. In this way regurgitation into the oesophagus that might be caused by lifting up the stomach is avoided. Thus regurgitated fluid may flow back again into the abdomen when the oesophagus is divided. The attachments to the spleen are delicate and must be carefully clamped and divided. Thorough hæmostasis is made. The clamped tissue is controlled by transfixing and tying it with plain catgut. The duodenum is doubly clamped with pedicle clamps and divided with the cautery. The stomach is lifted up using suction through the catheter at intervals. The stomach thus forms a kind of handle for the oesophagus, a valuable suggestion of Moynihan.

The loop of jejunum for the anastomosis is chosen with special reference to having the oral part of the loop sufficiently long to reach the diaphragm not only without tension, but with a redundant portion of it hanging well below the

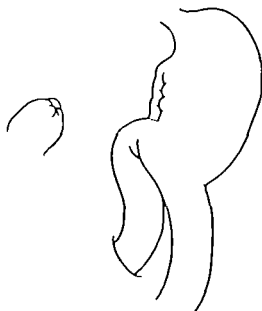


Fig 6 The scheme of the Holmstetter operation, a modification of the Billroth II shows the general principles of its technique. This is a variation of the Polya operation. In order to prevent confusion the colon is not represented in the sketch, but the loop of jejunum is brought up through a rent in the mesocolon. The upper part of the stump of the stomach is closed and the anastomosis of the jejunum is made with the lower portion of the stump of the stomach, instead of throughout its whole length.

transverse colon. The part of the loop to be anastomosed is isolated by small rubber bands which are thrust through the mesentery. These are superior to clamps and are less in the way. An interrupted suture of silk or linen is passed from the upper surface of the side of the jejunum, about halfway between the mesenteric and the convex border to the left portion of the posterior surface of the esophagus. The ends are left long. A similar suture is inserted between the right border of the esophagus and the jejunum, leaving space of about $1\frac{1}{2}$ to $1\frac{3}{4}$ inches (4 to 4.5 cm) between the two sutures (Fig 7). While these tractor sutures are held taut, a continuous suture of silk or linen unites the jejunum to the posterior wall of the esophagus. One end of the tractor suture may be utilized for this suture. The suction apparatus is disconnected from the catheter after the stomach has been thoroughly emptied, and a transverse incision is made in the posterior wall of the esophagus beginning on the right side. An incision is made in the jejunum about $\frac{1}{4}$ inch (0.6 cm) from the suture line. The esophagus and jejunum should be thoroughly packed around with moist gauze before the sutures are placed and

as soon as the opening into the esophagus and the jejunum is made the suction apparatus is applied. Beginning on the right side a linen or silk suture in a small curved needle unites the posterior margin of the incision in the jejunum to the posterior margin of the incision in the esophagus. The suturing is then continued until the left border of the esophagus and the left extremity of the incision in the jejunum have been reached. The incision in the esophagus is carried anteriorly catching the margin of the esophagus as it is cut in order to prevent retraction. The suture is continued around anteriorly uniting the anterior margin of the wound in the esophagus to the anterior margin of the wound in the jejunum. As far as possible it is well to apply this suture from within, drawing the suture snugly as it emerges from the inner surface of the esophagus, as has been described in the operation for partial gastrectomy. The suture is tied to its original end, on the right side. The ends of the tractor sutures are cut short.

The first row of sutures is again taken up and carried anteriorly as a continuous suture burying the inner row and is tied to its original end. Over this is placed a series of interrupted mattress sutures, preferably of No. 00 tanned or chromic catgut to give further strength to the union, and particularly reinforcing the two lateral borders. If any available peritoneal covered fat is found it should be brought over and caught with the long ends of these mattress sutures.

Instead of closing the stump of the duodenum, the right half of the jejunal loop is brought over and sutured to the stump of the duodenum end-to-side. By this procedure several things are accomplished. Once I lost a patient after a total gastrectomy because of a volvulus in the loop of jejunum that extended from the entero-anastomosis to the esophagus. By fixing the jejunum to the duodenum this accident can be avoided. Second, the duodenal contents can readily drain into this loop if there happens to be some blockage lower down. Third a duodenal fistula is less liable to occur with the easy emptying of the duodenum (Fig 7B).

At a point just below the transverse colon an entero-anastomosis is made between the two loops of jejunum and about 6 inches farther down a medium sized soft rubber catheter which has been passed through a stab wound to the left of the abdominal incision is introduced obliquely into the jejunum for feeding. This is done according to the method of Witzel, or better according to a modification of the Coffey principle.

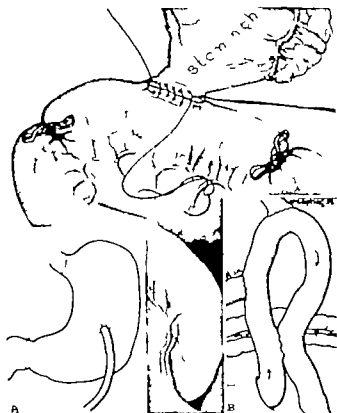


Fig 7 Total gastrectomy. The stomach has been severed from all of its attachments except the esophagus, and a catheter has been inserted in order to keep the stomach empty. Following the suggestion of Mayo-Robson, the stomach is turned up out of the upper portion of the abdominal wound onto the chest, and is used as a handle for exposing the esophagus. Tractor sutures of silk or linen are inserted at each border of the esophagus, and the jejunum and the esophagus are united with a continuous suture of silk or linen. Coprostanas of the jejunum is provided by narrow rubber bands thrust through the mesentery. The dotted lines indicate where the incision will be made into the esophagus and into the jejunum. Insert A shows the rubber catheter in position. Insert B shows the anastomosis of the esophagus and jejunum, the union of the stump of the duodenum to the jejunum, and the entero-anastomosis.

Owing partly to the extensive manipulation and to the multiple openings in the bowel, and to the exposure of the esophageal lumen, infection is much more likely to occur following this procedure than in partial gastrectomy, where drainage is rarely if ever needed. Through a stab wound in the left loin a long medium sized soft rubber drainage tube with several additional perforations is carried up to the cavity left by removing the cardiac end of the stomach. This tube fixed by suture to the skin, should not be in contact with the line of sutures but about an inch from it.

This operation is rather prolonged but by using continuous intravenous injection of dextrose in Ringer's solution and giving a transfusion of blood after the operation, shock can be combated.

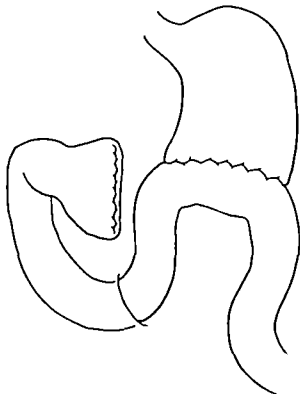


Fig 8 The Devine operation. The stomach has been divided between the two clamps, one of which has been thrust through the rent in the mesocolon. The distal stump of the stomach is closed, and the proximal end united to the jejunum after the manner of a Pólya operation. It is then, if possible, drawn down through the rent in the mesocolon.

PALLIATIVE OPERATIONS

Not infrequently a large fungating tumor of the stomach, which is often a colloid cancer, will give a better prospect for cure than a small cancer which ulcerates and metastasizes quickly. Dr W J Mayo's apt remark that cancer *coming to you* is less malignant than cancer *going from you*, is real wisdom. However, these large cancerous masses may be found so adherent and extensive around the pylorus as to defy any reasonable effort at resection. When this is the case a type of palliative operation such as that suggested by Devine of Australia for certain lesions in the pyloric end of the stomach and a modification of which has been used by Pack of the Memorial Hospital in New York for pyloric cancer may be adopted. This operation seems to have all of the advantages and none of the disadvantages of gastro-enterostomy. Clamps on the stomach are placed the clamp on the oral side being inserted through a rent in the mesocolon. The stomach is severed between clamps, preferably with the cautery, about the middle of the body of the stomach, leaving ample margin for infolding the pyloric stump. The cardiac end is brought down

through the rent in the mesocolon and is sutured to the jejunum somewhat after the manner of a gastro-enterostomy (Fig. 8). Or as Pack does, both ends of the stomach may be closed and then a posterior gastro-enterostomy made. If this cannot be done, the jejunum may be united to the stomach in front of the transverse colon and an entero-anastomosis made lower down. In this way the diseased mass at the pylorus is shunted off from the course of the food and given complete rest. In the instances in which the mass proves to be not malignant, permanent recovery may be expected, but even when cancerous the growth of the neoplasm is to some extent retarded by the rest afforded the tissue, and a ready emptying of the stomach is secured.

As has been mentioned gastro-enterostomy has little if any place in the surgical therapy of gastric cancer.

In cancer of the cardiac portion of the stomach, where obstruction to swallowing is produced a gastrostomy according to the method of Janeway in which a strip from the anterior wall of the stomach with its base at the greater curvature is made into a tube for the gastrostomy is a good procedure. For a permanent gastrostomy this operation is superior to the oblique implantation of a tube according to the Witzel method, because it leaves a channel lined with mucosa which is not only more comfortable and more readily controlled, but which may be dilated and through which by means of a cystoscope radon implants can be inserted into the growth present in the stomach.

CONCLUSION

We have, then, operations applicable to the cure or to the relief of cancer wherever it occurs in the stomach. As the majority of cancers are in the pyloric portion and in the adjoining part of the body of the stomach, extirpation by the modification of the Billroth I described can often be done, or if this is inapplicable some form of the Billroth II may be used. When the cardiac portion is involved or when the stomach is extensively diseased, a total gastrectomy may occasionally be done. In inoperable conditions with obstruction, the operation of Devine when the cancer is in the pyloric end, or a gastrostomy according to the Janeway technique when the occlusion is at the cardiac end, may be used. With an accurate diagnosis and a skillful execution of these operations, many lives can doubtless be saved that are now given up as hopeless. Naturally stomach surgery requires training and experience and it will be found that with increasing experience cases that formerly were condemned as hopeless may sometimes be salvaged. This, of course, may mean a mounting rate of operative mortality but it will also mean an increased total number of cures and a larger number of cases that can be considered resectable.

REFERENCES

- BALFOUR, D. C. Indications for the surgical treatment of carcinoma of the stomach. *Surg. Gynec. & Obst.*, 1934, 59: 453-460.
 HODGKIN, J. Shelton. *Surgery of the Stomach and Duodenum*. St. Louis: The C. V. Mosby Co. 1933.
 ST. JOHN, FREDERICK B. The end results following surgical treatment of gastric cancer. Unpublished.

RADIUM THERAPY OF CARCINOMA OF THE CERVIX UTERI

THE STANDARD TREATMENT IN USE IN THE CANCER CLINIC OF THE WOMAN'S HOSPITAL, NEW YORK, AND A COMBINED STATISTICAL REPORT OF FIVE AND TEN YEAR RESULTS SERIES 1919-1929¹

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SINCE we commenced to treat cancer of the cervix with radium in 1919, we have published our 5 year results in 1925, 1928, 1930 and 1932. We have now completed 2 more 5 year series, or 10 series in 15 years, and are reporting our combined results.

As our experience increases we feel that a 10 year observation period gives us a more accurate evaluation of the curability of cancer by radiation therapy than the 5 year standard therefore we are including in this report our 10 year results as well.

The standard technique we employ has been practically stabilized since 1920, the essential features are as follows. The preliminary building up of the patient's resistance when indicated in cachectic cases is accomplished by giving a blood transfusion if possible, as suggested by Farrar, spinal anesthesia is employed (half dose only is necessary) instead of a general anesthetic when there is no contra indication. We believe anesthesia of some sort is necessary for accurate diagnosis and biopsy, and for the correct application of the radium in most cases. We give an initial dosage of 3,600 to 4,200 milligram hours of radium, depending on the extent and size of the cancerous growth. One hundred milligrams are placed intracervically with the equivalent of 1 millimeter of platinum screening, and in the periphery at the junction of the cervix with the vaginal fornices platinum needles (0.5 millimeter) containing 12½ to 13 milligrams each are inserted, or if the vaginal vault is invaded, 75 milligrams of radium in silver boxes are used in a spring colpostat similar in principle to that of Regaud.

In exceptional cases of extensive disease we have used from 6,000 to 6,700 milligram hours for the initial dose. Since 1930 high voltage X-ray therapy has been employed by Dr. McIntosh who is in charge of our X-ray Department according to the following technique in Class III and IV cases. Two series 6 to 8 weeks apart, 4 portals 800 r per portal, at 200 kilovolts 30 milliamperes, 50 centimeter distance 0.5 centimeter copper and 1 centimeter aluminum filter. The size of portals varies with the patient and the extent of disease. Occasionally a third series has been given.

Since June, 1933 we have been using the fractional treatment whenever it has been feasible to have continued control and co-operation of the patient. The same factors of milliamperage, filter and voltage are used, the distance is increased to 70 centimeters and a fractional distribution of dosage is given as follows. Two portals are treated daily on the same side anteriorly and posteriorly, each side of pelvis therefore, receiving treatment every other day. Two hundred r is given to one anterior and one posterior portal daily until all portals have received 2,000 to 2,400 r each. Occasionally 250 r per portal is given. The exact amount and speed of administration are judged in each individual case. This treatment takes from 3 to 3½ weeks and is not ordinarily repeated.

We are in accord with Dr. McIntosh's belief that this fractional method gives greater promise of success, and is preferable whenever possible in spite of its economic disadvantages. In cases with extensive disease we have lately been following the practice of Healy and others of preceding the radium application with the X-ray therapy.

Potassium permanganate douches and an elevated posture to promote drainage and separation of any slough are begun at once. In cases where there is an exuberant cauliflower mass protruding into the vagina, we remove it with the high frequency knife before applying the radium. Biopsies are all done with the same instrument.

We stress the importance of distance screening by distending the vagina with gauze to its capacity to keep the bladder and rectum as far away as possible from the radium rays, and we use a self retaining catheter to keep the bladder collapsed during the radium application. We believe that anchoring the radium tube in the uterus is an important detail.

The outstanding feature of our method, however is the frequent follow up inspection made by the surgeon himself throughout the 5 year period if at all possible. During the first 3 years a monthly inspection is made, and after that the patient is seen every 2 or 3 months. If the follow up examination discloses evidence of a beginning recurrence in the vaginal walls or fornices a further irradiation is given in time to check the recur

TABLE I.—FIVE YEAR END-RESULTS IN CARCINOMA OF CERVIX. PATIENTS SEEN FROM FEBRUARY 15 1919 TO MAY 15 1929

	Living	Five year survival rate per cent
Total seen	57	24.29 (absolute)
Total treated	439	3 relative
Untreated	8	
Untraced	3	0%*
(complete) follow-up	57	84%*

*Classed as dead from cancer

rence in its incipency. Our employment of repeated irradiations after the initial treatment is for metastatic outbreaks or residua in the vagina and consists of a relatively small dosage, usually in the form of platinum needles, although should the nature of the recurrence require it we use tubes or flat containers. The average dose ranges from 300 to 1,200 milligram hours, depending on the size and location of the recurrence. We attribute our success in saving some cases to the early discovery of a metastasis, occurring 2, 3 and 4 years or longer after the initial treatment. The value of a personal follow-up each month we believe cannot be overestimated. In no other way can we detect early recurrences long before the patient has subjective symptoms.

We have been criticized for this practice of repeated irradiation, but we believe criticism is due to a misunderstanding as to our method. We are not employing repeated applications of a heavy dosage at the initial site of the disease. We appreciate that over radiation of radioresistant tissues may result in necrosis and fistulae and late radium reactions. We are of course, in agreement with the belief that the surviving cancer cells become more radioresistant after the initial irradiation, and that therefore the initial dose should be the maximum consistent with safety. Our initial dosage approximates that used in the leading clinics.

TABLE II.—FIVE YEAR END-RESULTS IN CARCINOMA OF CERVIX. PATIENTS SEEN IN TWO YEARS FROM MAY 15 1927 TO MAY 15 1929

Year	Total seen	Treated	Untreated	Five year survival Cases Per cent	Untraced
1927-8	7	41	4	27.46 (absolute)	
1928-9	13	53		31 (absolute)	
Total	20	94	4	28.46 (absolute rate)	(1%)

Relative five year survival 27.1%

Comparison of results by classes with other clinics must of necessity be only approximate due to the personal equation in estimating the extent of the disease. Heyman gave a well known example of this when three experienced gynecologists, visiting him in Stockholm all classed a case differently as to the extent of the cancer (The author Ward, was one of the three.) How often has it happened that an apparently early case with mobile uterus has been found at operation to have an invasion of the parametrium and glands?

It is our opinion that the simplest form of classification of the extent of the disease is the most useful for comparisons. Therefore we prefer Schmitz's, which we understand is used in this country by the majority of clinics.¹ The League of Nations classification is too complex to be practical in our belief and comparisons with other clinics are more open to error. However we use both systems for statistical purposes.

We believe that if cases were classified simply as "early" or "late" depending upon whether the disease has spread beyond the cervix, there would be less confusion and more accurate comparisons.

It is not correct, we think, to group League of Nations Class I and II cases together as "early" cases as Crossen has done since the League of Nations Class II includes a large number of Schmitz Class III cases which are not "early" but already have the disease extending into the parametria and vagina, but are nevertheless League

An inquiry made by us on October, 1931, of 1 of the leading clinics in the United States showed the per cent among the Schmitz classification, 1 of three also use the League of Nations, only 30 using the League of Nations classification alone. Two use personal classification.

TABLE III.—TEN YEAR END RESULTS IN CARCINOMA OF CERVIX PATIENTS SEEN FROM FEB 15, 1919—MAY 15 1924

		5 year survival as of May 5, 1929		10 year survival as of May 4, 1934	
		Living	Survival rate per cent	Living	Survival rate per cent
Total seen	208	54	5.96 absolute	8	17.78 absolute
Total treated	207	54	26.73 relative	3.96%	5.31 relative
Untraced	6				5.15%

Includes one case on information since proof available

TABLE IV—OPERABILITY IN CARCINOMA OF CERVIX

	Number	Per cent of total
Total cases seen	457	100.0
Operable—limited to cervix	94	20.6
Class I Schmitz	0	0
Class II Schmitz	85	18.6
Isoperable—extended beyond cervix	265	70.4
Class III Schmitz stages II and III—L of N	217	47.5
Class IV Schmitz stage IV—L of N	48	10.5

TABLE V—CASES OF CARCINOMA OF CERVIX SUITABLE FOR RADIUM THERAPY

	Number	Per cent of total
Total cases seen	457	100.0
Cases treated with radium	470	96.1
Untreated with radium	18	3.9

Radium operability 96.1 per cent

of Nations Class II because "the uterus still maintains some degree of mobility. The League of Nations Class II corresponds to an early Schmitz Class III in our opinion. Our cases with the disease limited to the cervix according to Schmitz's classification show Class I 2 per cent, Class II 18.6 per cent, or 20.6 per cent for our early group—not 60 per cent as has been stated.

As accurate classification of the extent of the disease must of necessity be difficult and will always be variable as the judgment of different observers varies, therefore comparisons where complicated systems are employed are of doubtful accuracy. We believe with Stoekel Mikulicz, Heyman and many others that only the absolute survival rate of an entire series is dependable for purposes of comparison.

As to our use of re radiation of recurrences in the vaginal tract, the following case seen recently is an example of our procedure.

Mrs. R. came to the clinic with a Class III adenocarcinoma of the cervix invading the vaginal vault. She was given 6,000 milligram hours at the initial treatment in the uterus and vaginal vault. This was followed with two series of high voltage X ray therapy. The result was apparently entire disappearance of the disease, with perfect healing. Six months later the patient felt well and was without symptoms, but at the monthly inspection a metastatic nodule, the size of a large pea, which bled to touch, biopsy positive, was found just inside the introitus on the right vaginal wall. This was promptly re radiated with radium needles.

We would ask our critics, what would they do under such circumstances?

Heyman in an address before the Royal Society of Medicine in 1929, stated "We have in recent years in cases of persistent small residua and in cases of smaller vaginal recurrences made use of intubation of radium needles. We do likewise

TABLE VI—AGE DISTRIBUTION IN CARCINOMA OF CERVIX

Years	Number	Per cent of total
20-29	21	4.6
30-39	90	19.7
40-49	153	33.5
50-59	129	28.2
60-69	50	10.9
70-79	13	2.9
80-89	4	0.9
Total	457	100.0

Youngest—24 years

Oldest—87 years

4.6% of the patients were under 30 years of age.

TABLE VII—PRIMARY MORTALITY OF RADIUM TREATMENT FOR CARCINOMA OF CERVIX

	Cases treated with radium	Radium applications	Deaths	Deaths per 100 applications	Deaths per 100 cases
Total, all classes to date	626	905	10	0.00	1.6
Class I Schmitz (Stage I)	16	2	0	0	0
Class II Schmitz (L of N)	116	81	0	0.54	8.6
Class III Schmitz (Stages II & III, L of N)	461	745	5	0.66	1.1
Class IV Schmitz (Stage IV, L of N)	29	43	4	0.3	3.8
Class V Schmitz (Stage V, L of N)	3	3	0	0	0

rather than not give the patient a chance and our results in many cases seem to justify this practice.

From February 15 1919 to May 15, 1934, we have had under our care 657 cases of carcinoma of the cervix, 630 of which have been treated with radiation therapy. 27 were left untreated since the disease was too far advanced. Including the new 1928 and 1929 series we now have 457 cases in which the 5 year observation period has been completed to May 15 1934.

The complete statistics are shown in the following tables.

Table I shows the 5 year survival rate of all cases seen from 1919 to 1929 inclusive.

Table II shows the 5 year end results in the last two series 1927-29.

Table III gives the 10 year end results from 1919 to 1924. This table shows that more than two-thirds of the patients surviving 5 years have lived 10 years or longer in spite of the lowered life expectancy of their respective age groups.

The untreated cases were, in our judgment, too far advanced for treatment (Table V).

Table VII shows that many Class IV cases probably should not have been treated.

TABLE VIII.—CARCINOMA OF CERVIX FOLLOWING SUPRAVAGINAL HYSTERECTOMY

	Number	Per cent
Total cases seen	437	
Postoperative strump	27	5.99
Living 5 years	11	
Absolute survival		40.7

TABLE IX.—FIVE YEAR END-RESULTS ACCORDING TO EXTENT OF DISEASE. SCHMITZ CLASSIFICATION OF CARCINOMA OF CERVIX CASES

Class	Total seen	Treated	Un-treated	Living 5 years	Absolute survival per cent	Relative survival per cent	Ab- solute & relative
I	0	0		6	66.6	66.6	100
II	61	61			30	30	50
III	117	117		61	52.1	44.4	85
IV	46	46	8				
Total	124	124	8	67	52.39	45.15	

It is to be noted that this table shows that "early" cases Class I and II had an absolute and relative survival rate of 51 per cent and the "late" cases Class III and IV had an absolute survival rate of 11 per cent and a relative rate of 11 per cent.

Table VII excludes 107 cases with previous or subsequent treatment or operation elsewhere, or treated previous to May 1920, when method was unstandardized.

Our results have been obtained during a period in which our X-ray therapy was inadequate, judged according to modern practice. Our series from 1910 therefore should show an improved survival rate.

SUMMARY

During 15 years at the Woman's Hospital we have had under our observation for 5 years or longer 457 cases of carcinoma of the cervix, 410 of whom have been treated with radium.

These 10 five year series have a relative (treated) survival rate, 5 years or longer of 55.8 per cent and an absolute survival rate (all cases seen) of 44.9 per cent with a completed follow up of 91.04 per cent. All untreated cases are classed as dead of cancer. "Early" cases showed 51.1 per cent survival.

Two hundred and eight cases have been observed for 10 years or longer and have a relative survival rate of 18.31 per cent and an absolute rate of 11.99 per cent. This shows that more than two-thirds of the cases that survived 5 years lived 10 years or longer in spite of the normal death expectancy in the various age groups.

TABLE X.—FIVE YEAR END-RESULTS ACCORDING TO EXTENT OF DISEASE. LEAGUE OF NATIONS CLASSIFICATION OF CARCINOMA OF CERVIX CASES

Stage	Total seen	Treated	Un-treated	Living 5 years	Absolute survival per cent	Relative survival per cent
I	64	64		3	4.7	7.3
II	179	179		46	25.7	25.7
III	131	131		16	12.2	11.5
IV	49	49	13			
Total	373	373	13	65	24.39	21.25

TABLE XI.—FIVE YEAR END-RESULTS ACCORDING TO EXTENT OF DISEASE. COMPARISON BETWEEN SCHMITZ AND LEAGUE OF NATIONS CLASSIFICATIONS

Classification	League of Nations	Total seen	Treated	Un-treated	Living 5 years	Absolute survival per cent	Relative survival per cent
I & II	I	64	64		49	76.6	73
III	II & III	117	117		61	52.1	59.8
IV	IV	46	46	8			

TABLE VII.—FIVE YEAR END-RESULTS IN CARCINOMA OF CERVIX TREATED BY UNIFORM WOMAN'S HOSPITAL RADIUM TECHNIQUE (COMPARE WITH TABLE I)

	Total	Treated	Living 5 years	Absolute survival per cent	Relative survival per cent
Total	373	373	65	24.39	21.25
Cases I & II Schmitz stage I, II of N. Limited to cervix	124	124	67	54.84	54.84
Cases III & IV Schmitz stage III, IV of N. Extended beyond cervix	149	149	38	25.50	25.50

*The figures in parentheses are of Table I.

A frequent personal follow up of all cases throughout the 5 year period of observation is essential if we are to discover early metastatic recurrences or recidiva in the vaginal tract before subjective symptoms develop, and in time to arrest the recurrence.

Re-radiations of this character are of definite curative or palliative value in many cases.

The classification of the extent of the disease should be simplified to the utmost degree to make comparisons with other clinics of value.

The classification of Schmitz is less complicated than that of the League of Nations, and we believe is in more general use in this country.

The absolute-cure rate of all cases applying for treatment, in our opinion, is the only criterion of value in comparing methods of therapy.

The frequent personal follow-up inspection made by the surgeon himself throughout the 5 year period of observation will not only result in fewer untraced cases and therefore improve his absolute survival rate, but it will also enable him to save more patients.

REFERENCES

1. CROSSAN. *Am. J. Obst. & Gynec.*, 1934, 28, 378.
2. HEYMAN. *Proc. Roy. Soc. Med.* 1929 22 Section Obst. & Gynec. p. 35.
3. Idem. *Surg., Gynec. & Obst.* 1930, 50, 173.
4. VON MICKULICZ-RADECKI. *Arch. f. Gynaek.*, 1933.
5. WARD. *Surg. Gynec. & Obst.*, 1933, 56, 434.
6. WARD and FARRAR. *J. Am. M. Ass.*, 1935, 85, 159.
7. Ibid. 1938, 91, 296.
8. Idem. *Surg. Gynec. & Obst.* 1931, 53, 556.
9. Idem. *Am. J. Obst. & Gynec.* 1931, 22, 543.

UNILATERAL CARCINOMA OF THE BREAST TREATED BY SURGICAL OPERATION AND RADIATION¹

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MANY theories have been advanced to explain the etiology of carcinoma of the breast, but none has been proved. The most generally accepted opinion as to the course of the disease is that it begins as a localized lesion and is disseminated to other parts of the body by way of the lymph stream and occasionally by the blood stream. It is on this conception of the disease that its treatment by surgical operation is based with a view to complete eradication of the disease. The possibility of accomplishing this objective depends on the extent of the disease at the time of operation and the type of surgical procedure instituted. The effectiveness of surgical treatment is indicated by the results obtained. The surgical results may be influenced by the use of roentgen rays and the effectiveness of the roentgenological treatment depends, to some extent, on the degree of malignancy.

The surgical procedure most generally accepted for the treatment of carcinoma of the breast is radical amputation, the fundamental principles of which were set forward by Halsted and by Willy Meyer, working independently, in 1888. There was an epochal contribution to the treatment of carcinoma of the breast, for since their publications surgical treatment has been the most effective method of combating the disease.

RADICAL AMPUTATION

The technique of the primary radical amputation has been fairly well standardized. I do not make a uniform type of incision in the skin for I believe that the best results are obtained when the incision is planned in each case so as to remove the greatest amount of skin around the region of

the growth, and to leave the least deformity and the least restriction of motion of the arm. If the incision is properly planned, in accordance with the situation of the tumor, sufficient skin can be removed so that there is little danger of local recurrence, and skin grafting is rarely necessary except when the lesions are most extensive. In general, if the tumor is in the upper or lower quadrant of the breast, a vertical incision will give the best results in the way of complete removal of the growth and adequate exposure for deep dissection. If the growth is in the extreme inner or outer quadrant of the breast, a transverse incision is usually best.

After the incisions in the skin have been outlined, the subcutaneous tissue is dissected around the entire operative field, the median portion of the dissection being carried to the median line, the lateral portion is carried to the border of the latissimus dorsi muscle, extending below to include the tissue over the upper portion of the fascia of the rectus muscle and extending above to the clavicle. Approximately two-thirds of the clavicular portion of the pectoralis major muscle is then divided, and its attachment is severed from the humerus. The lymph nodes along the upper portion of the brachial vessels are thoroughly removed, and the dissection is carried to the lower border of the pectoralis minor muscle. The attachment of this muscle to the coracoid process of the scapula is severed. The dissection of the axillary and sternal lymph nodes is completed, and all of the nodes are removed along the lateral wall of the thorax, along the axilla, both above and below the axillary vessels, to the entrance of the axillary vein into the thoracic wall. The branches of the axillary vessels

vessels are caught and ligated as the dissection of the lymph nodes proceeds toward the sternum the long thoracic and subscapular nerves are preserved. This completely outlines the tissues to be removed which are still attached to the wall of the thorax they include the breast, subcutaneous tissue, axillary nodes and node bearing fascia, the pectoralis minor muscle, and the greater portion of the pectoralis major muscle. These structures are then dissected from the wall of the thorax, starting from the lateral aspect the perforating intercostal vessels are ligated as the dissection proceeds. The anterior sheath of the rectus muscle is removed as the dissection proceeds toward the median line, and the entire carcinomatous portion is removed in one mass.

From the standpoint of operative procedure, the best results from surgical treatment of carcinoma of the breast are obtained from primary radical amputation. There are many variations in methods of carrying out the minor details of the radical amputation but the fundamental principles of the operation are invariable and should be carried out in all cases accepted for surgical treatment. This initial treatment is by far the most important procedure and the possibility of a cure depends on the thoroughness with which it is carried out. The importance of this cannot be overestimated, for secondary operative procedures are rarely curative. I believe that one of the important factors in the unsatisfactory results obtained from surgical treatment is the relative frequency with which minor operative procedures are carried out for malignant disease. The most unsatisfactory results from surgical treatment are obtained from secondary radical amputations, following a previous minor operative procedure. Approximately 7 per cent of our radical amputations at the Mayo Clinic have been secondary procedures of this type. In this group lymphatic involvement had occurred in 79 per cent of cases, as compared with 64 per cent in which primary radical amputation had been done. The results of the secondary radical amputation are correspondingly less satisfactory. These figures, however, do not give the true results in those cases in which a primary minor operative procedure had been done because in approximately 60 per cent of these the condition was hopelessly inoperable at the time the patients presented themselves for examination. This is particularly true of cases in which some type of escharotic had been used among these cases more than 80 per cent were inoperable at the time of our examination.

TWO TYPES OF CASES

From the surgical standpoint, lesions of the breast may be grouped in two classes first, the group in which a clinical diagnosis of malignancy can be definitely established and a primary radical amputation can be done immediately and second, the group in which the diagnosis cannot be definitely established on the basis of clinical manifestations of the disease.

In those cases in which a definite clinical diagnosis can be made, the disease is usually fairly well advanced and immediate, primary radical amputation is indicated. Inasmuch as one of the most important factors in the results of operation is the extent of the disease at the time of operation, the results will depend on the extent of the lesions of patients who are accepted for operation. Statistical studies on the results of operation are often misleading and do not give the true conception of the results obtained, unless it is known where the line is drawn between operable and inoperable growths. If only small lesions without demonstrable axillary metastasis should be considered acceptable for surgical treatment, the statistical results would be very satisfactory. This, however, would include only a relatively small number of patients, for the majority of patients present fairly well advanced lesions at the time of their initial examination. In most cases, the lesions are more extensive. Many patients present ulcerated lesions of the breast and metastasis to axillary lymph nodes. Radical surgical treatment cannot be expected to effect cure in these cases but in many instances can give comfort and additional life and I believe the patients deserve the benefit of surgical treatment.

There are varied opinions as to what constitutes an operable condition. I shall state briefly the criteria of operability followed in this series. Any lesion of the breast was considered operable if it was freely movable from the thoracic wall, regardless of ulceration and in some cases even if there were cutaneous nodules proximal to the tumor. The condition was considered operable regardless of the presence or absence of palpable axillary lymph nodes and in some cases in which supraclavicular nodes were palpable and were confined to one side of the neck the condition was considered operable. Patients were also accepted for operation if they presented the diffuse type of malignant disease, so called inflammatory malignancy or if the breasts were in a state of lactation, or in most cases, if patients were pregnant. The condition was considered inoperable if there was a large growth fixed to the thoracic wall and if there was extensive metastasis to the regional

TABLE I.—FIVE YEAR RESULTS COMPARISON OF CASES IN WHICH AXILLARY INVOLVEMENT WAS PRESENT WITH CASES IN WHICH IT WAS NOT PRESENT

	Patients operated on		Lived 5 or more years after operation	
	Total	Traced	Patients	Per cent of traced
Without axillary metastasis	1280	1086	776	71.4
With axillary nodal metastasis	30	3051	363	27.5
Total	3381	3737	339	42.7

lymph nodes or to distant parts of the body. In a few cases, in which there was distant metastasis, the patients were accepted for operation because of exceptional circumstances. It is difficult to draw any sharp line between operable and inoperable lesions, and treatment should be instituted according to the findings in each case. All patients were accepted for operation if it was thought that they had a reasonable chance of obtaining greater comfort or longer life from the surgical treatment or if there was ground for hope that the disease could be completely eradicated. It may seem that these rules which govern operability have not been drawn strictly enough, and that patients have been accepted for operation whose growths were too extensive. This is a matter of opinion, and the justification for operation is found in many cases in which the condition was thought to be absolutely hopeless before operation but in which the patients have lived and have enjoyed many years of comfort following the operation. I do not believe that the presence or absence of palpable axillary lymph nodes should be a criterion of surgical treatment, because I do not believe that it is possible definitely to ascertain whether this enlargement is the result of metastasis on clinical examination in all cases. Of cases observed in the past year palpable nodes were found in 60 per cent and in 68 per cent of these definite axillary metastasis was found at the time of operation. In the remaining cases the enlarged nodes were found to be only inflamed. In the 40 per cent of cases in which enlargement of the axillary nodes was not found clinically, axillary metastasis was present in 29 per cent. In these cases the metastatic nodes were under the pectoral muscles, and along the axillary vein, where they could not be felt on clinical examination. In view of the frequency with which these palpable nodes are found to be only inflamed on microscopic examination, I do

TABLE II.—FIVE YEAR RESULTS COMPARISON OF CASES IN WHICH OPERATION WAS PERFORMED WITH CASES IN WHICH BOTH OPERATION AND ROENTGENOLOGICAL TREATMENT WERE CARRIED OUT

	Patients operated on		Lived 5 or more years after operation	
	Total	Traced	Patients	Per cent of traced
Surgery alone without axillary metastasis	531	494	345	69.8
Surgery and radiation without axillary metastasis	649	591	431	72.8
Surgery alone with axillary metastasis	649	604	147	24.3
Surgery and radiation with axillary metastasis	1359	1447	416	28.8
Total	3381	3737	1330	43.7

not believe that surgical treatment should be refused in these cases.

The second group of cases consists of those in which a diagnosis cannot be definitely established on the basis of clinical manifestations of the disease and these cases present a more difficult problem. This is the most important group from a surgical standpoint. In a general way, the malignant lesions of the breast which do not present the characteristic signs of malignant disease clinically are usually early lesions, and the most satisfactory operative results are obtained from surgical treatment in these cases. In the indeterminate clinical cases the question may arise as to whether it is better to keep the patient under observation or to treat the condition surgically. In all cases in which there is a single localized tumor, without definite clinical signs of malignant disease, the only safe course to follow is to establish a definite diagnosis by surgical removal of the tumor for microscopic examination. The tumor should be removed by wide excision, well away from the limits of the growth, without trauma to the lesion or surrounding tissues. Usually I prefer to remove a wedge-shaped piece of tissue including the margin of the growth, and well away from it. Microscopic examination of the tumor should be made immediately after its removal, before the wound is closed. If the tumor proves to be malignant, the operation should be completed as a radical amputation, if it is benign the breast can be reconstructed with very little deformity. I do not believe that it is ever advisable to remove any growth from the breast without immediate examination of a frozen section of the tissue, the manner of completing the operation is indicated by the results of this examination.

TABLE III.—FIVE YEAR RESULTS RELATIONSHIP BETWEEN INVOLVEMENT OF AXILLARY NODES AND GRADE OF MALIGNANCY

Treatment	Grade of malignancy	With involvement of axillary nodes				Without involvement of axillary nodes			
		Patients operated on		Lived 5 or more years after operation		Patients operated on		Lived 5 or more years after operation	
		Total	Traced	Patients	Per cent of traced	Total	Traced	Patients	Per cent of traced
Surgery only		4	4	4	100	29	29	7	93
		40	35		87.5	67	64	46	71.6
	3	74	163	45	27.3	32	72	45	62.5
	4	176	216	34	7	26	24	47	25
Surgery and roentgen rays		8	8	8	100	23	26	26	100
			107	49	45.8	60	5	44	85.3
	3	426	424	15	3.5	24	8	49	60.4
		778	722	90	9	113	30	122	64

RESULTS

In the accompanying tabulations, all patients operated on have been included in the surgical results, regardless of the extent of the disease at the time of operation and a high percentage of cases is included in which all that could be hoped for was palliation. The tabulations also include those cases in which a primary operative procedure had been carried out elsewhere, followed by a radical procedure at the clinic, as well as those cases in which the prognosis was influenced by other associated conditions, such as diabetes, exophthalmic goiter, pregnancy, lactation, and diffuse cancer *en castris*. It is not within the scope of this paper to discuss the results obtained, classified according to the various groups. I shall publish these in a subsequent paper.

In this paper I shall give the 5 year results obtained from radical amputation for unilateral carcinoma of the breast. I shall then compare the 5 year results obtained in those cases in which radical amputation constituted the complete treatment, with the 5 year results in cases in which roentgen therapy was administered, in addition to performance of radical amputation. I shall also compare, according to the 4 grades of malignancy the 5 year results obtained by surgical treatment only, with those obtained by surgical treatment and roentgen therapy together. These results are based on all cases in which operation was performed at the clinic from January 1, 1910 to January 1, 1929, this permits the compiling of 5 year results in all cases. The cases numbered 3,381 and the results are based on 3,137 cases in which the patients were traced, or 92.64 per cent of the entire series.

In Table I are compiled the 5 year results of treatment by radical amputation. The entire series has been divided into two groups for comparison depending on the presence or absence of involvement of axillary lymph nodes at the time of operation. In Table I it is shown that the results were much better in the cases in which axillary metastasis to lymph nodes had not taken place before the time of operation. Therefore, the presence or absence of metastasis to axillary lymph nodes at the time of operation is one of the most important indications in estimating prognosis. I believe that in all studies on the results of treatment of carcinoma of the breast, division into these two main groups should be made as an initial attempt to obtain uniformity of types of cases for comparison of results.

In Table II are recorded the 5 year results obtained in cases in which radical amputation only was done, for comparison with the 5 year results obtained in cases in which radical amputation was followed or was preceded by roentgen therapy. This study shows that (as compared with similar patients who were subjected to radical amputation only) 3 per cent more patients without axillary nodal metastasis lived 5 years, who received roentgen therapy in addition to radical surgical treatment. Among cases in which axillary nodal metastasis was present, a similar comparison disclosed that 4 per cent more patients lived 5 years, who received roentgen therapy in addition to radical surgical treatment. Whether treatment was by surgery only or by surgery and roentgen rays, the difference in the percentage of comparable patients who lived 5 years was small. By "percentages of comparable patients" I mean

to compare the following percentages in Table II 69.8 with 72.8 24.3 with 28.8. In all of the comparisons of comparable patients the percentage of those who were living at the end of 5 years was slightly higher among those who received both surgical and roentgenological treatment than among those who received only surgical treatment. It would appear, therefore, if the differences in percentages are great enough to be of any significance that the better results could be attributed to roentgenological treatment. It should be emphasized, however, that the differences with which we are dealing are small and that perhaps a larger series of cases would not show any materially better results in cases in which roentgenological therapy was added to the surgical treatment.

It is of greatest interest to subdivide each of the two main groups (the group of cases with, and the group of those without, axillary nodal metastasis) into 4 classes according to the grade of malignancy, making 8 classes in all. I believe that the comparison of the results of any type of treatment are most accurate when comparisons are made according to this classification. The grading in these cases has been done according to Broders' method of dividing malignant lesions into 4 grades, based on cellular differentiation. This part of the study is based on 2,396 cases, which are all of the cases in this group of 3,137 traced cases in which the growth has been graded. It was found that cases of grade 1 comprised 60 cases or 2.88 per cent of the total, cases of grade 2, 288 cases or 12.02 per cent of the total, cases of grade 3, 796 cases or 33.22 per cent of the total and cases of grade 4, 1,243 cases or 51.88 per cent of the total. It is shown by these percentages that in 85 per cent of cases of malignant disease of the breast, the growths were of malignancy graded 3 and 4. This is an important factor and influences the results of surgical treatment because in comparison with growths of other grades, those of high grades of malignancy are more often associated with axillary nodal metastasis at the time of operation. As is shown by a study of these 2,396 cases in which the grade of malignancy was determined, 17.4 per cent of patients whose growths were of grade 1 had axillary nodal involvement at the time of operation and the same was true of 55.9 per cent of those whose growths were of grade 2, of 79.2 per cent of those whose growths were of grade 3, and of 88.8 per cent of those whose growths were of grade 4. This study shows that the majority of the malignant lesions of the breast are of high grades of malignancy, and that these high grades

TABLE IV—COMPARISON OF LENGTH OF LIFE OF PATIENTS TREATED BY SURGERY ONLY AND BY SURGERY AND ROENTGEN RAYS

	Total patients operated on	Patients dead		Average years before death
		Number	Per cent	
Surgery alone				
No glandular involvement	527	240	45.80	5.17
With glandular involvement	649	528	81.44	2.8
Surgery and post-operative radiation				
No glandular involvement	649	246	37.90	4.22
With glandular involvement	718	1202	77.45	2.5

of malignancy are most often associated with axillary nodal metastasis at the time of operation, this is one of the most important factors in prognosis.

Part of the foregoing paragraph has been derived from Table III, which was compiled as the basis of a study of 5 year results in relation to grade of malignancy. The cases were divided into 2 main groups, those in which there was axillary nodal metastasis at the time of operation and those in which axillary nodal metastasis was absent at the time of operation, and each of these main groups was divided into 4 classes according to the grade of malignancy of the growth. Comparison was then made in each of the classes between the cases in which treatment was by surgery only and those in which both surgery and radiation were used. This study shows that there was practically no difference in the results obtained in cases in which malignancy was of grade 1, whether surgery only was used, or whether both surgery and radiation were employed.

In cases in which malignancy was of grade 2 the comparison, as before, was between patients who were treated by surgery only and patients who were treated by surgery and roentgen rays. The results were rather paradoxical among patients with axillary nodal involvement, the larger number of those who lived 5 years were treated by surgery only among patients without axillary nodal involvement, the larger number of those who lived 5 years were treated by surgery and roentgen rays. To continue this comparison in cases in which malignancy was of grade 3 among patients with axillary nodal involvement the larger number of those living were treated by surgery and roentgen rays whereas among patients whose axillary lymph nodes were not involved the larger number of living patients were treated by surgery only. Now, concerning cases in which malignancy was of grade 4 among patients whose axillary nodes were affected as well as among

those whose axillary nodes were not involved, the larger number found to be living at the end of 5 years had been treated by surgery and roentgen rays.

In comparing the results in cases in which treatment was by surgery alone with those in which treatment was by surgery and radiation although the study discloses no significant difference in the results obtained, as has been said and substantiates the former study. It indicates that there may be some improvement in the results obtained in high grades of malignancy particularly if axillary nodal metastasis is associated. When treatment is by surgery and radiation and the grade of malignancy is low radiation as an adjunct to surgical treatment seems to be of no value.

This study shows that the grade of malignancy gives the most important indication as to the prognosis, for patients whose growths were of grade 1 lived the longest period of time and patients whose growths were of grade 4 lived the shortest length of time. This holds true whether or not axillary nodal metastasis was present or absent.

In Table IV is recorded a study of the patients who died of malignant disease of the breast following operation or following operation and radiation in this group of cases the complete end-results are definitely known. This study was made to determine the length of life of those patients who were treated surgically only as compared with those who were treated by surgery and roentgen rays.

This study shows that patients treated by radical surgical operation only and who presented no axillary nodal metastasis at the time of operation lived on an average of one year longer than a similar group of patients who were treated by surgery and radiation. Patients treated by radical surgical operation only and who presented axillary glandular metastasis lived approximately

6 months longer than the group of patients treated by radical surgical operation and radiation. These figures are significant and indicate that roentgen therapy is of no definite aid in radical surgical treatment of carcinoma of the breast and they also indicate that it may be detrimental to the results of surgical treatment in some cases. These figures, however are not conclusive because a smaller percentage of patients who underwent both surgical operation and roentgen therapy were dead at the time of the compilation of these results, and as the end results are obtained on a higher percentage of these cases than this, the tendency will be to lessen the difference in length of life of patients of the two groups.

COMMENT AND CONCLUSIONS

The most efficient surgical treatment for carcinoma of the breast is primary radical amputation. The results depend on the thoroughness with which this procedure is carried out in an initial operation.

This study reveals that roentgen therapy has been of no significant aid as an adjunct to radical surgical treatment and should be used not as a routine treatment but only if the malignancy is of high grade for the 5 year results indicate that it may be of aid in cases in which malignancy is of high grade.

The end-results in cases in which the patients have died show that the patients who were subjected to surgery only lived longer than those who were subjected to both surgery and roentgen therapy. In these cases it is evident that roentgen therapy was not of aid to surgical treatment and may have been detrimental to it in some cases.

The most important factors in prognosis are the extent of the disease, as shown by the presence or absence of axillary nodal metastasis, and the degree of malignancy as shown by microscopic examination of the lesion.

STANDARD METHODS OF TREATMENT OF CANCER OF THE LIP
BY SURGERY AND RADIATION¹

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WHENEVER the practice of medicine becomes static whenever the medical profession is in perfect accord in regard to the best method of handling any disease, at that moment will the art of the practice of medicine become dead. The "aliveness" of the art of the practice of medicine is nowhere more clearly demonstrated than in a consideration of the various methods advocated for the treatment of cancer of the lower lip. However, while we fully recognize the sincerity and honesty of various workers in this field we cannot consider seriously any method of treatment which does not carry with it certain logic based upon the known pathology of the disease. While there have been great changes in therapy due to the discovery, first, of X ray, later of radium with their unquestioned destructive effects upon malignant tissue, the pathology of cancer of the lip is the same today as it has always been. True, in certain clinics and among certain physicians the diagnosis of cancer of the lip may be made at an earlier stage and hence the average case which presents itself for treatment may be different from the average case of 50 or 100 years ago, yet the processes involved in the causation (whatever they may be) and the dissemination of cancer of the lip are exactly the same.

The problem of treatment involves two distinct phases first—and much the more immediately important to the patient—the treatment of the primary, visible lesion second—and equally important in a large percentage of cases—is the handling of the lymph nodes which become secondarily involved. Theoretically speaking no patient should ever die of cancer of the lower lip. The vermillion border and the mucocutaneous margin are so plainly visible to the patient, to his family and friends, that any lesion at this site ought not to escape his attention. Should the lesion start upon the mucous membrane surface on the inside of the lower lip, the patient cannot help but be aware of it in the early stages through feeling it with his tongue. Thorough destruction of the primary lesion in its early stages is such a simple matter that it should never be possible to have a recurrence. The lymph channels which drain the lower lip are so circumscribed, so constant, so accessible, and the lymph nodes into which they empty are likewise so constant in their

distribution and so accessible, that the problem of metastases is also a comparatively simple one. Yet cancer of the lip still exacts a considerable annual toll in human life, and because of an improper understanding of the disease or faulty treatment, many patients must undergo severe pain or mutilation or both in order that the physician may obtain a result which could have been obtained in the incipient stage of the disease by a comparatively insignificant procedure.

In the handling of a considerable number of cases of any disease the physician consciously or unconsciously divides the cases into different groups, each of which is handled according to more or less rigid rules. In the treatment of cancer of the lower lip certain standards can be evolved. These standards should be determined by the extent of the disease, the location upon the lip, the general condition of the patient (including his psychological reaction to his disease), the available facilities for treatment and the histopathology of the lesion. In regard to primary cancer of the lip one can say that any method which completely destroys the tissue that contains cancer is permissible. It has been shown beyond controversy that radiation when properly employed either by X ray or radium will effectually destroy the primary lesion. It has likewise been shown that surgical excision, either with the scalpel or the high frequency cutting current, can effectually remove the invaded tissue of the lip. These facts are so well recognized that I shall only briefly enumerate the relative advantages and disadvantages of each method. Radiation destroys cancer, in all probability, by direct action upon the cancer cells (which are less resistant to the destructive action of radiation than normal tissue cells) plus such a degree of alteration of the normal tissue in which the cancer cell lies that life for the cancer cell becomes impossible although life of the normal tissue cell, while changed, still goes on. This difference between the viability of the cancer cell and the normal tissue cell makes it possible, with radiation, to destroy cancer of the lower lip with a minimum of loss of normal tissue and hence minimal deformity. With surgery this difference in viability is not a factor and the effectiveness of treatment depends upon absolute removal of all the normal



Fig. 1 First case at Barnard Free Skin and Cancer Hospital of carcinoma of lower lip treated by radiation from radium, February, 1918. Neck dissection 3 months after treatment of lip. Patient still living free of evidence of carcinoma.



Fig. 2 A, Satisfactory result can confidently be expected from proper use of radium. Neck dissection indicated regardless of histology of tumor. B, Lip healed. Suprathyoid dissection complete. Patient well 7 years later.

tissue in which the cancer may lie as well as the actively involved cancer tissue. This necessarily results in loss of much normal tissue. Radiation can be administered without hospitalization and without loss of the patient's time from business or social activities. Surgical removal on the other hand, although not necessarily disabling to the patient, will usually require some loss of time and sometimes hospitalization. Discomfort to the patient from radiation is most variable. Rarely will a patient go through the subsequent reaction without some inconvenience or pain. In surgery pain and discomfort are not great; they occur almost immediately and last a comparatively short time as compared to the long drawn-out healing from radiation. Hence in the average case it will be seen that there is not a great deal of choice. For my own part, it is my practice to excise with the scalpel lesions up to one centimeter in diameter by means of V excision. Lesions larger than this are treated by radiation with radium. This general rule does not apply to lesions of the

mucoous membrane, particularly at or near either angle of the mouth. I regard these lesions as distinctly of more serious import than lesions of the vermillion border or of the mucocutaneous junction. Such lesions are treated with wide surgical excision and immediate repair of the resultant defect by utilization of tissue from the upper lip.

It is difficult to lay down hard and fast rules for radium therapy because, in different clinics, the quantity of radium available, type of applicators and type of ray employed are subject to such wide variation. But some rules should be standard. First, the area to be irradiated should comprise a great deal more than the visible or palpable margins of the growth. Second, the estimated "dose" should be given in one sitting or within a limited time. Third, if the estimated dose (and dosage should be overemphasized rather than underestimated) has failed to cause complete retrogression, radiation should not be persisted in. It is well to remember that tissue irradiated to the point of destruction of cancer is not favorable tissue for



Fig 3. Almost identical case to Figure 2. Prophylactic neck dissection repeatedly urged and refused until large "bull-like" metastasis appeared in submental region. Neck dissection too late. Patient died 2 years after first consultation.

kindly wound healing should surgical excision of recurrence or plastic repair of defects become advisable. On the other hand, should surgical excision of the primary lesion be the method of choice for the first attempt at eradication and should recurrences appear, radiation may be employed without regard to the operative wound, always with the reservation, however, that any scar tissue is apt to react unfavorably to radiation. Also, let me sound a warning—no one has the right to undertake the treatment of cancer of the lower lip with the idea in mind that if one method of treatment fails another may be tried. He who first treats the condition has the golden opportunity. If he fails to obtain a cure

the patient's chances are reduced at least 50 per cent irrespective of the subsequent method of treatment.

Discussion of the topic of treatment for the second phase of the disease, namely, treatment of the regions of lymphatic involvement by metastases, develops a veritable battleground of divergent opinions. The theory of radiation in the treatment of cancer in the lymphatic system is based upon the power of either roentgen- or radium rays to penetrate the skin and to impinge themselves upon the cancer cell with enough destructive energy to kill it. There is another theory that through radiation the lymphatic channels are blocked so that the cancer cell cannot



Fig. 4



Fig 5



Fig. 6.

Fig 4. Primary lesion left side lower lip successfully healed by radium. Large metastasis in submaxillary region, fixed to periosteum of mandible, but still operable. Patient advised and accepted complete left neck dissection.

Fig 5. Very obvious case of existence of crossed metastasis. Indicates necessity for bilateral suprahyoid resection

of lymph-bearing area in every case.

Fig 6. Lip "blown out" in fashion by radiation. Repair very difficult due to devitalization of normal tissue. Note metastasis in submaxillary region which did not respond to interstitial radiation. (*Ann. J. Surg.* 1934, 54 No. 5.)



Fig. 7 Example of possibilities of successful surgery in advanced case. Repair satisfactory from cosmetic and functional viewpoints.

wander through these channels. Still a third theory is that radiation is effective through its power to cause a marked thickening of the capsule of a lymph node in which cancer may lie to such an extent that even though the cancer cell may live, it cannot grow through this capsule. The great drawback to the practical application of these theories is the undisputed fact that radiation does not have the same effect upon all cancer cells and neither does all normal tissue react similarly to radiation. The most telling observation to be made in regard to the practice of radiation therapy in the treatment of possible metastases from cancer is that the so called prophylactic radiation therapy is given with a great deal less intensity than when radiation is employed as a possible curative agent when metastases are definitely present. The logic of this common practice is to me obviously fallacious.

There was a time in the first twenty years of radiation therapy when the radiologist received for treatment only such cases as were not accept-

able to the surgeon. Now the pendulum has swung in the other direction and the surgeon is seeing more and more the patient who has passed through the hands of the radiologist and comes to him in the hope that something can still be done after radiation has failed.

The surgical removal of the subcutaneous lymph-bearing tissue which immediately drains the lower lip is an anatomical feat which involves the absolute removal from the body of a certain amount of tissue in all cases. The lymph channels from the lower lip are unusually constant and the lymph nodes into which they drain are located above the hyoid bone and extend from the lower one-third of one parotid gland to the other. Primary metastases to more distant nodes are exceedingly rare as are, also, metastases to the lungs, mediastinum or more distant parts of the body. Contrary to some writers on this subject, I have found crossed metastases of frequent enough occurrence to justify bilateral removal of tissue in all cases regardless of the location of the



Fig. 8 Example of possibilities of interstitial radiation. Patient's general condition did not warrant radical surgery. Patient barely survived pain and toxemia accompanying slow destruction by use of radium. Plastic repair was very difficult due to devitalized normal tissue which bor-

dered upon the defect. Final result was a water tight mouth, but a poor cosmetic appearance. Patient died 5 years after treatment. Autopsy disclosed bronchiectasis, but no evidence of carcinoma. (*Am J Cancer* 1937: 15, No. 3.)

primary lesion. The operation is performed in the same manner whether or not lymph nodes are palpable. The only qualification of this statement is that should metastases be proved in certain groups of lymph nodes it is recognized that the disease has probably gone beyond the area of initial operation and an extended surgical interference is indicated. This procedure is entirely logical as it concerns itself purely with the pathology of the disease. Its disadvantages are manifest, inasmuch as it subjects the patient to a major surgical procedure which in a certain proportion of cases will be unnecessary, since all cases of cancer of the lower lip do not form metastases.

Naturally such an operation should not be advocated for a patient who is a poor surgical risk with an estimated life expectancy of 3 years or less. But the number of patients who present themselves, 3 to 5 years or longer after the lip has healed with advanced metastases to the cervical nodes has caused me to believe that to heal the lip lesion without removal of the immediately draining lymphatic area is just as great a mistake as for instance to remove the breast for cancer and let the axillary lymph nodes remain behind untouched.

Undoubtedly the ideal surgical treatment of cancer anywhere in the body is a one stage operation which removes the primary lesion and the regional lymphatic system at one time. This ideal can be attained in cancer of the lower lip. Stewart in 1909 advocated and described such an operation. It is to be recommended for the treatment of cancer recurrent after any form of treatment and in cancer of the mucous membrane surface of the lip. But since radiation in any stage of the disease and V excision for the small lesion has proved of such value in the treatment of the primary lesion, treatment has logically fallen into the two stages already described.



Fig. 9. Result following Stewart operation for small lesion on mucous membrane surface

But when should the second stage be performed? As yet we have no reliable data upon which to base an estimate as to the time at which metastasis occurs. The assumption that palpable nodes in the presence of demonstrable primary cancer means metastases in these nodes has been proved erroneous. In a recent study of this question of metastases from cancer of the lip the writer found that of 42 cases with palpable nodes 28 were diagnosed hyperplastic and 14 carcinomatous on microscopic examination. In 13 cases the records showed definitely that the nodes were not palpable yet in 2 of these 13 cases carcinoma was found on microscopic study. It is manifest that the clinical evidence of metastases, in a large proportion of cases, is entirely unreliable.

Obviously it cannot be considered logical to subject a patient to the surgical attack on the lymph channels unless it is reasonably certain that his primary lesion is healed. For a number of years I have adopted the following rather arbitrary practice in regard to time of removal of lymph nodes after radiation of the primary lesion. If there are no lymph nodes palpable at the time of treatment of the primary lesion wait 3 months (local recurrences following radiation will usu-



Fig. 10. Result following Stewart operation for extensive lesion lower lip. Entire lower lip reconstructed.

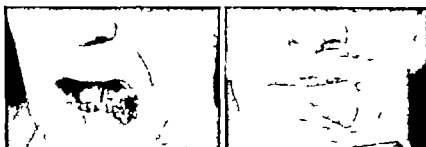


Fig. 12 Result following swing of tissue from upper lip to replace excess tissue of lower lip for lesion near the angle of the mouth. (*Am. J. Cancer* 1931 15 No 3)

ally show themselves within this time) When nodes are palpable but movable, and not over 15 millimeters in largest diameter wait 6 weeks. If the nodes are fixed, or hard, and most probably carcinoma the operation for their removal is undertaken as a definite part of the initial treatment of the primary lesion, preferably at the same sitting. Occasionally the general condition of the patient will necessitate a division of treatment into two or more stages. These are usually desperate cases in which cure is hardly to be hoped for and as stated previously if metastases are present in any of the nodes above the hyoid

bone, subsequent operation for removal of the deeper lymph channels and lymph nodes must be performed on one or both sides. This operation extends from the clavicle to the mastoid process, and its degree of success is to be measured by the thoroughness of its performance.

In the case of V excision unless it is necessary to wait for confirmation of the diagnosis of cancer by microscopic examination of the excised tissue, the suprahyoid neck dissection is per-



Fig. 12A Superficial lymphatic vessels and nodes which drain the lips (after Pomeroy and Cuneo). Note the interlacing immediately beneath the vermilion border and the long distance the vessels course in the superficial fascia before they dip toward the deep structures.

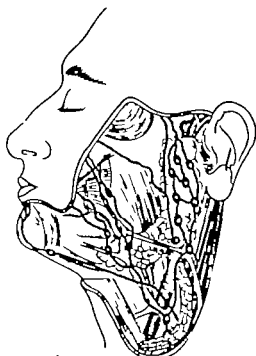


Fig. 12B Deep lymphatic system of the upper neck. The following locations of nodes are important: lower parotid region, submandibular region, submental region, and the region along the facial vessels, above the lower border of the mandible. (*Am. J. Cancer* 1931 15 No 3) (After Toldt.)

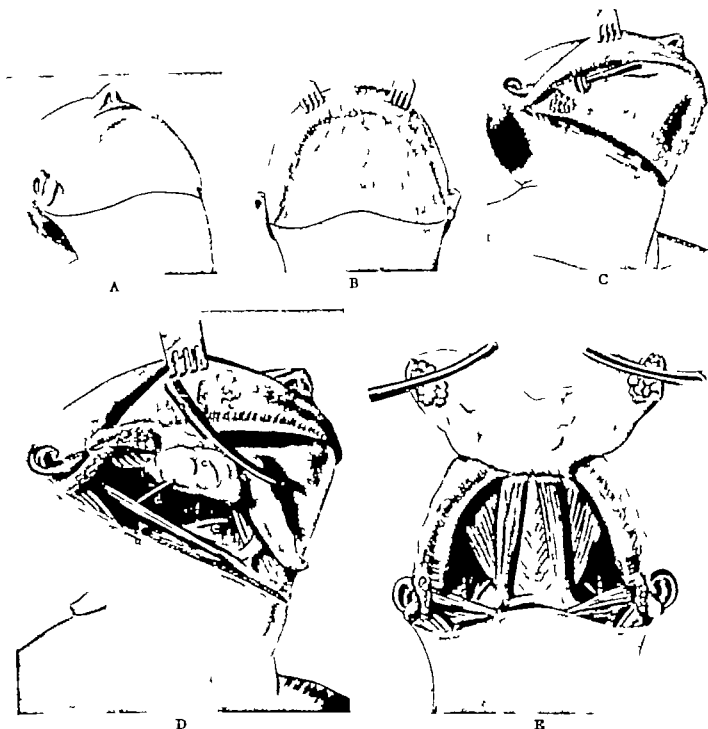


Fig. 13. A, First step. Skin incision carried only through the thickness of the skin. B, Second step. Deepening of the line of incision through the platysma myoides muscle and superficial fascia to the deep fascia. C, Third step. Showing the common facial vein ligated as it pierces the deep fascia, and the ligation of the facial artery and vein above the border of the mandible. D, Fourth step. The lower third of the parotid gland, all tissue above to the

depth of periosteum of the mandible, and the deep fascia below have been raised the facial artery is freed for ligation as it enters the capsule of the submaxillary salivary gland. *a*, Common facial vein. *b*, Parotid salivary gland (cut). *c*, Submaxillary salivary gland. *d*, Facial artery. *e*, Hypoglossal nerve. E, Fifth step. Dissection completed on both sides. The amount of tissue removed is plainly indicated. (*Am J Cancer* 1931 15 No 3)

formed at the same sitting. Should delay be occasioned by the lapse of time for the aforementioned confirmation of the diagnosis, the operation for removal of the lymph nodes is undertaken as soon as possible after the lip wound has healed.

Radiation, either from the radium bomb or from the X ray tube of proper voltage, has its strong advocates both as a prophylactic and curative agent in the treatment of metastases. There is little carefully checked clinical evidence advanced

to support this method. The fractional treatment by X ray (or radium) as advocated by Coutard has lately gained many sponsors. This method impresses me as more dangerous than surgery and requires much further trial before it can be generally accepted. Interstitial radiation on the other hand, has something to recommend it. When accurately employed, tumor tissue itself will absorb the brunt of the intensive radiation. Its success will depend upon the radiosensitivity of the tumor, the correct estimate of dosage and the accuracy of its application. The last can best be attained through operative exposure of the field to be irradiated. While I have yet to see a case of proved metastases cured by this method, I have observed such marked palliation without severe reaction to the patient that its use is to be recommended for inoperable cases.

I have not found the grading of either the primary tumor or of metastases to be of great value. We know that the more highly differentiated the tumor cells are, the less malignant and the less radiosensitive the tumor is apt to be. The converse is also true. Yet there are so many exceptions to this rule that it is not fair to the individual patient to base choice of therapy and prognosis

entirely upon the macroscopic appearance of the tumor.

SUMMARY

The treatment of cancer of the lower lip must be divided into two phases: the treatment of the primary lesion and the treatment of the adjoining lymphatic system.

In view of our present knowledge, the treatment of the primary lesion can be standardized. The important consideration is destruction of all cancer cells wherever they may be, and the structure of the lower lip permits this to be accomplished with equal certainty by either radiation or surgery. Practical considerations for the use of either method are described.

There is no standardized method for treatment of the lymph channels. The writer questions the value of radiation as a curative agent in the presence of metastases and finds no proof that its prophylactic use is warranted. Surgery when properly executed is definitely prophylactic and in many cases curative. Radiation has a place as a palliative procedure, its best effects being obtained by interstitial radiation, preferably combined with surgical exposure of the area to be radiated.

THE STANDARD TREATMENT OF MALIGNANT TUMORS OF THE BLADDER¹WILLIAM E. LOWER, M.D., F.A.C.S., CLEVELAND, OHIO
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THE frequency with which carcinoma of the bladder is encountered makes the consideration of what may be done for the unfortunate patients afflicted with this disease one of importance to every practicing physician and especially to every urologist. In the Cleveland Clinic we have found that malignant tumors of the bladder constitute 5 per cent of all cases of malignant disease in general, and almost half (44 per cent) of all cases of malignant disease in the genito-urinary tract.

Although there is no spectacular improvement or advancement in the treatment of this condition to discuss at the present time, perhaps an inventory of the situation may offer some encouragement and renewed hope for the future in combating vesical carcinoma. There have been no striking innovations recently, but by comparing the results obtained now with those of 20 years ago it is evident that there has been a slow but gradual improvement as the result of better diagnostic methods and of technical improvements in surgery and radiation therapy.

But the improvement in results already noted does not, in my opinion, mark the end of the road, for armed with these technical improvements and with the knowledge gained from the reviews of large series of cases, we may be able to reconsider and re-evaluate the criteria for operation with the result that more radical procedures will be undertaken in a greater proportion of cases with consequent improvement in end results.

A more optimistic outlook regarding bladder tumors is encouraged by the facts that the bladder is not a vital organ and can be widely resected or completely removed without jeopardizing the processes necessary to life, and also that bladder tumors tend to remain localized for longer periods of time than do cancers in many other parts of the body. The records show, of course that the proportion of local recurrences in the bladder is greater than elsewhere in the body but this tendency could probably be corrected by earlier diagnosis, more rigid vigilance regarding examinations subsequent to operation, and by more radical treatment at the outset.

The methods of treatment of carcinoma of the bladder have included fulguration, cauterization, diathermy, radiation with radium and roentgen

rays, and various types of surgical removal, including excision, partial resection of the bladder and total cystectomy. All of these methods are still in use, and each has a definite field of usefulness, depending on the indications in the individual case determined by such factors as age, general condition, type of neoplasm, grade of malignancy, and the site of the lesion, as well as the technical skill and experience of the operator.

To accomplish a cure in any case of malignant tumor no matter where it is situated, demands that the growth be completely removed or entirely destroyed. Nothing less radical suffices. As long as the cancer remains localized, every effort should be made to remove it.

Unfortunately the complete removal of tumors in the urinary bladder offers difficulties which are sometimes insurmountable. Complete excision is seldom possible when the lesion occurs in the region of the base, the trigone, or the bladder neck. These areas are involved in 60 per cent of the cases in our experience. The growths which occur laterally even though they involve a ureter, or those at the vault of the bladder can be excised locally and should be so treated. A wide resection should be made for even though a large part of the urinary bladder is removed the remaining part expands to give ample vesical capacity, as has been demonstrated by the experimental work of Kretschmer. Patients who have had extremely wide resections of the bladder usually have very little discomfort.

If the ureter be involved, resection must include that part of the ureter. If the ureter is divided extraperitoneally, no special transplantation need be made for it will function, even though it is set back some distance. Provision should be made however, to prevent the formation of a stricture by eversion of the mucous membrane. If this does not seem feasible, the ureter may be transplanted in some higher point of the bladder. If transplantation is not possible, there can be no serious objection to ligating the ureter and putting the kidney out of commission, provided it is not infected and the opposite kidney is functioning normally.

Even in the case of recurrent malignancy in the bladder, a second resection may produce a brilliant result. In one patient on whom I operated,

there was a recurrence within a year. A second resection was done and the patient has been free of the growth for 25 years. This experience shows that a local recurrence is no contra indication to repeated attempts at excision of the growth.

In cases in which local excision or resection of a tumor of the bladder is impossible, total cystectomy may be done with the assurance of relief from the distressing symptoms attendant on an ulcerated, infected lesion in the bladder. Because of the relatively low incidence of distant metastases from bladder neoplasms, the indications for so radical a procedure as cystectomy are greatly enhanced.

Despite the indications for the procedure and the probability that the results would be as good or better than those from radical operations in other parts of the body, cystectomy has not been widely or generally used because of the technical difficulties involved. A transplantation of the ureters into the rectum is prerequisite to removal of the bladder. This operation requires a great deal of surgical skill and experience. Furthermore the excision of the urinary bladder is no undertaking for a novice in surgery.

Much of the improvement in the method of transplantation of the ureters and cystectomy we owe to the brilliant work of Coffey. His chief modification of the technique consisted of the application of the valve principle in the transplantation of the ureters into the rectum. In his final contribution to the literature, he reported a series of 11 cases in which the bladder had been completely removed. Seven of these patients were alive and well for periods of 4 months to 5 years. His comparatively low operative mortality rate of 27 per cent and the period of freedom from recurrence made the outlook in this type of case much more promising.

Recently Dr. Charles C. Higgins of the Cleveland Clinic has made a further modification of the operation for uretero-intestinal anastomosis in which the ureters on both sides can be transplanted at the same operation, without interruption of the flow of urine into the bladder until the new channel between the ureter and bowel has been established. This method decreases the likelihood of pentoncal infection, which has been the greatest cause of death in this type of operation, and diminishes the morbidity after operation.

With these improvements in the operation, cystectomy is being performed with increasing frequency and I firmly believe that the more generally this operation is utilized, the less will be the proportion of recurrent and metastatic malignant lesions from bladder tumors.

When for any reason, surgical removal of the bladder does not seem feasible, fortunately another mode of attack, radiation, is available. The application of radium and roentgen rays for the wholly inoperable cases has given results that are most encouraging, in many instances. The indiscriminate use of small or large doses of radium by persons unfamiliar with its use and action has caused condemnation of a method of great merit. The best results in radium therapy can only be obtained by the close co-operation of physicist, pathologist and clinician.

The work of Barringer at the Memorial Hospital in New York demonstrates the value of skill and experience in the use of radium for the control of bladder neoplasms. In a series of 98 cases in which the clinical diagnosis was supported by biopsy 52.9 per cent of the patients with papillary carcinoma and 29.7 per cent of the patients with infiltrating carcinoma were alive and had no evidence of disease, according to cystoscopic examination, at the end of 3 years. Barringer feels that radium treatment is the method of choice and that the results to be expected from radiation are as good as those from surgery. The accessibility of the tumor must govern the choice of transurethral or transvesical approach, and in all instances, an attempt should be made to apply a sufficiently large primary dose to destroy the tumor completely.

The same considerations are true of roentgen radiation. Since roentgen therapy has become a special field in medicine, the results of this type of treatment have been greatly improved. Deep roentgen therapy, however, in the treatment of bladder tumors is not so effective as the application of radium. In our own experience its use has been mainly palliative, but it may give many days and months of comparative comfort to an otherwise miserable creature. The occasional remarkable symptomatic relief and local regression of an extensive growth suggests that more widespread application in less formidable lesions might demonstrate a greater field of usefulness for this type of therapy. With the introduction of higher voltage machines in roentgen therapy it is quite possible that the results of this type of treatment might overshadow all others in malignant tumors of the bladder, especially if surgical procedures would be extremely difficult, or impossible.

Although surgical removal and radiation are respectively the most important methods of treatment in cases of carcinoma of the bladder, fulguration and cautery may still be useful in certain cases, especially in very small lesions, extremely early growths or those of a very low grade of

malignancy. The important point, of course is to destroy the lesion entirely, and if that can be done by some less radical procedure, the results obtained may be excellent. Several of our patients were thus treated very satisfactorily.

Surgical diathermy has been advocated by a number of urologists, and seems to produce good results in certain cases in which operation can not be performed (7, 10). It probably has some place in the armamentarium of the urologist in certain types of cases.

SUMMARY AND CONCLUSIONS

As has already been mentioned most authorities agree that the incidence of distant metastasis from tumors of the bladder is considerably lower than from other neoplasms. The Carcinoma Registry of the American Urological Association (3) has estimated that metastasis occurs in only 10 per cent of the cases. Other estimates have placed this figure at 20 per cent or even higher. Some writers have contended that the incidence of metastasis depends on the degree of malignancy of the lesion (7). In view of these statements the report of Smith and Mintz is most interesting, for they state that in a study based on 34 post mortem examinations at the Massachusetts General Hospital, metastasis was revealed in 16 instances, or almost 50 per cent. Their demonstration that the tendency to metastasize is not related to the grade of malignancy is significant and indicates clearly the necessity for regarding every case of tumor in the bladder as either potentially or actually cancerous.

The Carcinoma Registry found in an analysis of 902 epithelial tumors of the bladder that there had been a recurrence in 46 per cent of the cases (3). They also have pointed out that the incidence of metastasis is higher in cases in which the tumor is most easily resectable, that is, high in the vault of the bladder. Most of these tumors were found to metastasize to the liver, because of the direct pathway through the lymphatics of the hypogastric vessels. These facts emphasize the necessity for increased vigilance in following the course of each patient after operation and also show that more radical operations probably are indicated and might produce very much more satisfactory results.

In conclusion, although I have no revolutionary procedure to advocate in the treatment of carcinoma of the urinary bladder I feel that we should all be heartened by the evidences of the gradual development which has already been accomplished. Merely to contrast the results in a few relatively recent series of cases with those

reported by Watson in 1913 and by Gardner in 1915 shows that there has been a perceptible increase in the number of 3 and 5 year cures. They reported the number of 3 year cures following resection as 14 and 22.5 per cent respectively. In our own series 28.5 per cent of the patients subjected to operation and radiation have survived for 5 years or more. A recent series of cases reviewed at the Mayo Clinic (4) reported that 28 per cent of patients with carcinoma of the bladder survived 5 years or more. The Carcinoma Registry (3) in its recent report of 902 cases numbered the 5 year survivals at 33 per cent. At the time of Watson's and Gardner's reports the treatment was limited largely to excision and partial resection, whereas today we can resort to cystectomy with increasing confidence, and have recourse also to radiation therapy—an important adjuvant if not the sole hope of patients with advanced disease.

Today's results are still far from what we might wish and also, I believe, from what we may actually accomplish. With certain physiological and pathological factors more favorable than in tumors elsewhere in the body, we should face the problem of treatment of malignant disease of the bladder with new confidence that there will be a steady improvement in the final results in this type of case.

REFERENCES

1. BARRINGER, B. S. End-results of radium removal of carcinoma of the bladder. *J. Am. M. Ass.*, 1918, 90:357-354.
2. COFFEY, R. C. Transplantation of the ureters for carcinoma of the bladder with cystectomy. *Ann. Surg.*, 1930, 91:903-923.
3. Committee on Carcinoma Registry. Cancer of the bladder. A study based on 902 epithelial tumors of the bladder in the carcinoma registry of the American Urological Association. *J. Urol.*, 1934, 31:423-449.
4. COUNELLER, V. S., and WALKER, WALTER. Malignant tumors of the bladder—a review of 165 cases in which patients lived five years or more following various surgical procedures. *Surg. Gynec. & Obst.*, 1933, 56:413-449.
5. GARSTNER, J. A. Operative treatment of tumors of the bladder. *Ann. Surg.*, 1915, 62:456-463.
6. HIGGINS, C. C. Aseptic uretero-interstitial anastomosis. *Surg., Gynec. & Obst.*, 1933, 57:359-361.
7. HUNT, V. C. The surgical treatment of malignant tumors of the bladder. *J. Am. M. Ass.*, 1928, 91:1704-1708.
8. KRETSCHMER, H. L., and BARST, E. E. Regeneration of the bladder following resection. *J. Am. M. Ass.*, 1928, 90:355-358.
9. SYTH, G. G., and MINTZ, E. R. Bladder tumor—observations on 150 cases. *Am. J. Surg.*, 1933, 20:54-63.
10. WALKER, H. W. E., and PRACOCK, C. L. Diathermy in urology. *J. Am. M. Ass.*, 1924, 83:1142-1147.
11. WATSON, F. S. The surgical treatment of vesical papilloma and carcinoma. *Urol. & Cutan. Rev.*, 1913, 17:54-73.

SYMPOSIUM TREATMENT OF FRACTURES

ONE THOUSAND CONSECUTIVE FRACTURES OF BOTH BONES OF THE LEG¹

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TRAUMATIC surgery has come into its own. The wonder of it all is that it required the tragedy of a World War to focus our attention on the importance of this branch of medicine. As a specialty it lagged because the general practitioner treated trauma as a side issue—a bore and a hazard. He gave little thought to its importance and little study to its anatomy, pathology and end-results. The War forced the issue. Expansion of industry, development of automobile and airplane have broadened the field and sharpened the interest of our profession. Traumatic surgery now challenges the attention of our manufacturing plants, great and small. Industrial Commission awards which have been based on both anatomical and functional perfection in the results of fracture treatment have spurred this newer surgery forward. It is for this reason that the evolution in fracture treatment has had to be rapid. There has been much room for progress.

In a review of 1,000 consecutive fractures of the tibia and fibula covering a period of approximately 17 years, one's mind passes in review the numerous examples of cumbersome and expensive beautiful and worthless reduction apparatus which clutter our basements. Gradually simpler and better tools made their appearance. To be successful these appliances must be the result of sound physiological, reconstructive and rehabilitative reasoning.

When invited to present a paper at this meeting we felt that some of the rather obvious things in this group of cases would be interesting—possibly instructive.

We see many fractures, because the Corwin Hospital is the concentration point for diseases and injuries of the Colorado Fuel and Iron Company employees and their dependents. Our company operates a large steel plant in Pueblo, iron mines in Wyoming, coal mines and lime quarries throughout Colorado. All fractures of any consequence are splinted by the local physician and sent to us.

In considering fractures of both bones of the leg as an entity we note—

1 That this is a very frequent industrial injury.
2 That no other major fracture is compounded so frequently. This is due to the close proximity of the bones to the skin and to the terrific force required to fracture both bones.

3 That the site of fractures from direct violence is most frequently at the weakest point—the point between the middle and lower third of the leg. Fractures due to indirect violence are often of the spiral type.

4 That no other fractures are so prone to non-union. It is our opinion that muscle attachments with their rich blood supply have much to do with bone union. There is an absence of such attachments in the region of the middle and lower third of the leg. Besides, when fractured, the ends of the fragments usually are separated completely from surrounding tissue. If our original assumption be correct, it readily explains non-union in this situation.

5. That any trauma of sufficient force to fracture both bones usually greatly damages the soft parts. Sometimes our efforts are concentrated, therefore on the co-existing surrounding injuries rather than upon the bones themselves.

TREATMENT

In the time allotted we must be dogmatic and not argumentative. Whatever we have found of greatest value is here described.

1 Every severe fracture case is potentially or actually in shock. No reduction should be attempted until this complication is alleviated.

2 If not contra-indicated, the fracture should be reduced immediately and plaster cast applied. In the simplest fractures with little displacement we use local anesthesia. Even in these cases, however, we must have the active co-operation of the phlegmatic patient. Spinal anesthesia is ideal if we bear in mind its contra-indications. But our main reliance has been placed on nitrous oxide and oxygen with ether. Generally speak

¹Presented in the symposium on the Treatment of Fractures, before the Clinical Congress of the American College of Surgeons, Boston, October 28, 1934.

ing ether gives the greatest relaxation with the least hazard.

When the fragments are so fixed that we feel it practicable, a Boehler walking iron is incorporated in the cast. One of us (J.S.N.) became enthusiastic about this method after visiting the Boehler clinic. Further study, however, makes us believe that it is not safe to use it as routinely as Dr Boehler does.

3 Theoretically, every compound fracture should be made a closed fracture through immediate surgery. Unfortunately, the trauma may seriously damage blood vessels and nerves devitalize the skin, muscles, tendons, fat, and fascia. Our first investigation, therefore, should be concerned with the viability of the limb as a whole. Then our attention should be directed to the sterilization of the surrounding skin—shaving, scrubbing gently with soap and water, bathing in ether and finally applying tincture of iodine. All of this should be done with meticulous care so as not to contaminate the open wound with foreign substance. Next the wound is washed thoroughly with large quantities of saline solution. Tincture of iodine is then poured into the wound. While we do not feel that iodine will sterilize the multitude of crevices open to infection, we believe it should always be used. It probably helps. Apparently it does no harm.

Mechanical sterilization, however, is of the greatest importance. The skin edges are cut away. All devitalized tissues, whatever their character, must be removed by sharp dissection. Constantly we watch lest the scalp graft potential infection into clean tissue. Of late we have performed débridement with the "radio knife"—much to our satisfaction.

Sometimes, in severe wounds it may be almost impossible to trace all small crevices. Here we have found it of advantage to counterstain with methylene blue. The tracts may then be followed as is done so frequently in ramifying fistulae elsewhere in the body.

If the bones have been ground into dirt the ends are trimmed. Pieces of entirely detached bone are removed. Adherent fragments are placed in a position most advantageous for healing. Thus do we carry out débridement, with no finger contact technique.

The next step is to suture the severed soft parts, nerves, tendons, and muscles. Absolute hemostasis must be the rule. The skin is sutured without tension. If it cannot be approximated relaxation is accomplished by longitudinal incisions some distance from the wound. The skin is never undermined. Drainage is never inserted.

Extension is always applied by the skeletal method. We use almost routinely the Steinmann pin, rarely the long calipers or Kirschner wire. Traction is followed by applying a plaster cast.

4 Markedly comminuted fractures or those which we are not able to reduce early are treated by skeletal traction. For these we prefer a small Steinman pin through the os calcis and a Hawley suspension splint. It must be emphasized repeatedly that overtraction separates fragments and produces non-union.

5 While it is our policy to avoid open reduction when possible, we open spiral fractures of the tibia with the fibula broken high. We believe time, suffering and disability are thereby reduced to a minimum.

6 We prefer to use autogenous substance in our open reductions and almost never use non-absorbable material. Metal plates have been used with some excellent results, but experience urged us to abandon them.

7 During the recent past we have used an automatic device designed by Dr Roger Anderson of Seattle. This apparatus we believe is a most excellent tool for proper fixation of fractures of the leg. It is based upon simple anatomical principles with ample traction and facilitates manipulation. It does not interfere with the application of plaster and leaves the bones transfixed. Since it can be easily autoclaved, we have found this apparatus particularly helpful in our open work. Even with this apparatus let us emphasize once more the importance of preventing overtraction.

Sometimes we have accused ourselves of ultra conservatism in our attempts to save shattered limbs. How much simpler and easier to amputate! After months of constant treatment we may have a patient with a 50 per cent or even 25 per cent functioning limb. However, we have the satisfaction of knowing that psychologically this patient is far more of a man than were he to possess the best artificial limb that money can buy.

Of the 1176 fractures treated at Corwin Hospital since 1917, 1,000 were fractures of both bones of the leg.

In reviewing these cases we find a comparatively high proportion compounded, namely, 231. These were treated along the lines already set forth. In spite of these efforts 21 of them became infected, 31 failed to unite and subsequent bone graft was indicated. It was also necessary to reduce 54 fractures of other types by open method.

Amputation was necessary in 11 cases. These should probably not be considered here because of the primary seriousness of their injury. In the 1,000 cases there were 19 deaths. These were all

SYMPOSIUM TREATMENT OF FRACTURES

ONE THOUSAND CONSECUTIVE FRACTURES OF BOTH BONES OF THE LEG¹

WILLIAM SINGER, M.D. F.A.C.S. AND J. SIMS NORMAN, M.D. F.A.C.S. PUEBLO, COLORADO

TRAUMATIC surgery has come into its own. The wonder of it all is that it required the tragedy of a World War to focus our attention on the importance of this branch of medicine. As a specialty it lagged because the general practitioner treated trauma as a side issue—a bore and a hazard. He gave little thought to its importance and little study to its anatomy, pathology, and end-results. The War forced the issue. Expansion of industry, development of automobile and airplane have broadened the field and sharpened the interest of our profession. Traumatic surgery now challenges the attention of our manufacturing plants, great and small. Industrial Commission awards which have been based on both anatomical and functional perfection in the results of fracture treatment have spurred this newer surgery forward. It is for this reason that the evolution in fracture treatment has had to be rapid. There has been much room for progress.

In a review of 1,000 consecutive fractures of the tibia and fibula, covering a period of approximately 1 year, one's mind passes in review the numerous examples of cumbersome and expensive beautiful and worthless reduction apparatus which clutter our basements. Gradually simpler and better tools made their appearance. To be successful these appliances must be the result of sound physiological, reconstructive and rehabilitative reasoning.

When invited to present a paper at this meeting we felt that some of the rather obvious things in this group of cases would be interesting—possibly instructive.

We see many fractures, because the Corwin Hospital is the concentration point for diseases and injuries of the Colorado Fuel and Iron Company employees and their dependents. Our company operates a large steel plant in Pueblo, iron mines in Wyoming, coal mines and lime quarries throughout Colorado. All fractures of any consequence are splinted by the local physician and sent to us.

In considering fractures of both bones of the leg as an entity we note—

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¹Presented at the symposium on the Treatment of Fractures, before the Clinical Congress of the American College of Surgeons, Boston, October 24, 1934.

results are actually impossible. In many other cases, however, poor results may be due to the following factors

1. Insufficient anatomical reduction because of inadequate equipment.

2. Insufficient care of the wound followed by infection in open fractures.

3. Numerous vain attempts at conservative treatment in fractures which are of such a nature that perfect anatomical and functional results can be obtained only by operative intervention.

4. Lack of skill and experience in the technique of operative treatment of fractures.

5. Tardy hospitalization of poorly set fractures, with consolidation in incorrect position and permanent injury due to subsequent incorrect position of the adjacent joints.

This latter fact receives too little attention, not only from the general practitioner but also from the surgeon in some cases. The fracture must not be looked upon as an isolated injury but the bone, the muscles, and the adjacent joints must be considered as a functional and physiological unit.

6. In injured patients psychological factors must also be held partially responsible for unsatisfactory results. There are cases in which the anatomical position is perfect but the patient develops compensation neurosis and the result is functional impairment of the condition.

We will now describe briefly, on the basis of the extensive fracture material of the surgical clinic of the University of Freiburg (Germany) the methods by which we achieved the best results in operative treatment of fractures of the long tubular bones. Purposely very few figures will be given because statistics give little information concerning the ways and means by which good results are obtained in the individual case. Table II covers the fractures treated during a period of 7 years.

TABLE II

	Cases	Per cent
Total number of fractures treated	12,000	100.00
Treated in clinic (hospitalized)	1,245	10.37
Operatively treated	306	2.54
Bone plates	75	0.63

It will be noted, therefore, that of 12,000 cases 1,245, or 10.37 per cent, were hospitalized. Of these 1,245 cases 306, or 24.58 per cent, i.e., approximately one fourth, were treated by operation. In this latter group there were 75 cases, or 24.51 per cent in which plastic repair was done by means of bone plates.

Let us also consider a few data concerning the frequency of fractures of the long tubular bones and their skeletal distribution. Table III shows

the distribution and frequency in a collection of 9,160 fractures treated in the Freiburg clinic in the course of 6 years.

TABLE III

	Cases	Per cent
Total number of fractures	9,160	100.00
Upper arm	893	9.75
Forearm	1,850	20.31
Thigh	482	5.26
Lower leg	2,100	22.92

These figures show clearly the frequency with which fractures force the physician to be particularly exact in the matter of indications. The type of anaesthesia, the time of operation, the operative technique, and the preliminary and after treatment are all important factors in the individual indication. A brief review of each of these points is given in the following sections.

NARCOSIS OR ANAESTHESIA IN OPERATIVE TREATMENT OF FRACTURES

If the type and location of the fracture and the procedure to be used in treatment are such that the physician can manage without general anaesthesia, local anaesthesia should be used. In extensive interventions—bone plating for instance—in psychically unstable patients, general anaesthesia should always be given. In fractures of the lower leg in which operative reduction is easily accomplished by approximating the fragments with a hook, local injection is sufficient. When wire is to be applied to fractures of the lower leg and of the thigh we frequently use lumbar anaesthesia. In cases in which the fractured bones lie close to the surface we occasionally inject novocaine at the point of fracture, as recommended by Boehler. In the upper extremity one can sometimes use Kulenkampf's plexus anaesthesia. We have frequently used it with good results but in a few instances the results were unsatisfactory. Koenig urgently recommends cross-sectional anaesthesia, in which radial injection down to the bone is done at 4 or 5 places about a handbreadth above the region of operation, so that the novocaine solution acts upon the periosteum, the muscles, and the skin. Infiltration must be done also along the line of incision. In operations which can be completed within a short time I have recently begun using intravenous Evipan anaesthesia, especially in fractures of the lower leg in some cases local anaesthesia is combined with it. This combined method has shown itself to be excellent.

¹ Details about this combination of local and intravenous anaesthesia in fractures are being published in *Anaesthesia and Analgesia* 1935 March.

TIME OF OPERATION

Another important factor in good operative treatment of fractures is the time at which operation is performed. With the aid of examples let us now study a few types of fracture, in some of which immediate operation is indicated while in others, later operation is advisable. Of course we do not pretend to cover all possible types of fracture.

Immediate operative intervention is indicated in only a few cases

1 In complicated severely dislocated fractures of the lower leg. At the time of primary excision and wound treatment the misplaced ends of transverse fractures are approximated with a hook after conservative reduction has been found impossible.

2 In simple or compound, badly dislocated transverse and spiral fractures of the lower leg in which correct position cannot be achieved by immediate closed reduction.

3 In fractures of the forearm in which the dislocation of the 2 bones frequently cannot be corrected by closed reduction. Here it is often a matter of transverse fracture of the shaft, in which reduction may readily be accomplished by simple approximation.

4 In fractures whose dislocated fragments induce injury to nerves or vessels. In such cases operation sometimes shows the nerve riding upon the pointed fragment.

5 In joint fractures.

6 In cases with large fracture hematomata which may induce severe compression of vessels and nerves (ischæmia). This is known to occur in fractures of the elbow. Immediate relief should be given by splitting of the fascia, drainage of the hematoma, correction (with wire suture if necessary) etc.

In other words, the above types of fracture are those in which operative treatment should be given immediately. They are fractures lying superficially in which either conservative reduction is not possible or the associated skin injury demands operative treatment even though other soft parts are not particularly injured and finally this group includes fractures in which the associated injuries are such as not to permit delay in treatment of the fracture until the most convenient time.

In all other cases we usually look upon the second week as the optimal time for operative treatment of the fracture. Koenig, Lambotte, Rehn and others are of the same opinion and operate about the beginning or the middle of the second week. Lexer designates the fourth and fifth as well as the second week as favorable. He

bases his opinion upon his investigation which showed that fracture hyperæmia is most highly developed during this period. Doubtless the choice of time for operation is dependent upon the physiopathological processes which occur in connection with the fracture trauma. Along with the degenerative changes in bone, lacerated periosteum, and damaged muscles, which occur immediately after injury, there soon appear regenerative processes of which the surgeon makes use. In this connection the physiological response of the muscles plays a part which often is overlooked. The physiological balance of the muscle tone between flexors and extensors is a necessary factor in the healing of fractures. This is achieved only by firm fixation of the broken bone in good position. Immediately after fracture the muscles involved are in a state of subnormal excitability, which persists for about 8 days and is designated as a sort of 'muscular stupor' (Rehn). Then from the eighth to about the thirtieth day after fracture there is a state of 'intermittent tetanic hyperexcitability of the muscle'. The correlation between the fracture and the muscle is of outstanding physiopathological importance. This muscular activity is necessary in all of those places where the callus must be furnished by the periosteum alone i.e. in the diaphysis. It is encouraged by absolute rest of the injured member and extension according to physiological condition. Insufficient rest and too great a degree of extension prevent physiological activity of the muscles (electric action currents) and so defer callus formation. This retards healing of the fracture or prevents it entirely.

The large number of pseudarthroses or non-united fractures observed during the last few years is due partly to the fact that the fractures were not fixed firmly enough and were not left in the plaster long enough, or to the use of too great extension.

INDICATIONS

It is erroneous to suppose that operative treatment of fracture is permissible only after long use of conservative measures has proved useless. By postponement of necessary operative correction conditions may be created which impair the operative result or even make a perfect result impossible. We must see to it that operative treatment is given at a timely period in all cases. Operation should be done before the regenerative capacity of the fractured bone is exhausted and before retraction, contracture, atrophy of the muscles, and contractions of the capsule and ligaments of the adjacent joints have induced permanent injury.



Fig. 1. Spiral fracture of the lower leg with severe dislocation and interposition of musculature. When conservative measures failed operative reduction and suture with metal bands was done according to the method of Parham Putt.

Fortunately these views are gaining more and more ground, although even today there is still not complete agreement among the various authors. The statistics given above show that in our clinic 2.54 per cent of all fractures are treated by operative procedure. Magnus performed operation in 3 per cent of his cases, and the Goettingen clinic (Stich) in 2.8 per cent of all fracture cases. These figures come from 3 clinics with extensive bone material. One is probably justified, therefore in saying that approximately 3 per cent of all fractures must receive operative treatment. But if we consider the number of hospitalized cases we have a much higher percentage of operations i.e., 24.58 per cent, or practically one-fourth of the fractures.

Generally speaking operative treatment of fractures is indicated (1) when perfect anatomical reduction cannot be accomplished (2) when closed fixation of the fragments is impossible, and (3) when consolidation fails to occur.

We will now discuss these indications as they apply to individual cases and on the basis of our experience describe the effective operative treatment.

OPERATION IS INDICATED

1. When conservative measures have failed in spite of the use of all technical devices such as fracture table, countertraction wire extension etc. Numerous manipulations repeated at short intervals, contusions, and traction on the soft parts injured by the fracture enlarge the hematoma and disturb the physiological repair of the



Fig. 2. Left. Oblique fracture of the thigh with severe dislocation and impalement of the soft parts. When conservative measures failed operative reduction was done.

Fig. 3. An ideal anatomical result was obtained by wiring.

tissues. This increases the danger of slight or late callus formation and of subsequent pseudarthroses.

2. In fractures in which muscle interposed in the fracture makes conservative reduction impossible from the beginning.



Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4. 14 year old boy; osteitis fibrosa generalisata (v. Recklinghausen's disease) in the upper and lower end of the right femur and in the upper end of the left femur.

Fig. 5. Spontaneous spiral fracture of the right femur.

Fig. 6. Operative reduction and fixation of the fragments by metal splint fastened laterally to the bone with 4 wires. In spite of the pathological change in the bone the picture shows adequate callus formation. Splint and wires are firmly embedded and healed over. Condition 3 months after operation.



Fig. 7

Fig. 8

Fig. 9

Fig. 7 Transverse fracture of the thigh in a man, aged 25 years. Attempt at reduction by means of extension, plaster cast, and wire traction was unsuccessful. The fragments were angulated due to muscular traction and interposition of soft parts. There was weakness of the callus with danger of pseudarthrosis.

Fig. 8 For this reason the fracture was exposed and splinted with a plate of bone from the tibia. Excessive proliferation of the callus on the medial side of the shaft.

Fig. 9 Fracture after 8 months. It is in good position and well healed. The transplanted bone is firmly fused with femur. The marked callus proliferation has receded.

3. In cases of interposition of tendons, for instance the long biceps tendon which in some instances constitutes an absolute hindrance to closed reduction.



Fig. 4

Fig. 13

Fig. 14

Fig. 4 Severe double fracture of the shaft and neck of the humerus. Conservative reduction failed.

Fig. 13 Condition 6 years after operative treatment. Splinting of the shaft fracture with autoplasmic plate of bone from the tibia. The fracture is firm, the transplanted bone and the wires have healed over without reaction.

Fig. 14 The head of the humerus, which was broken off completely, was wedged into position by open operation. It is firmly healed and there is perfect function.

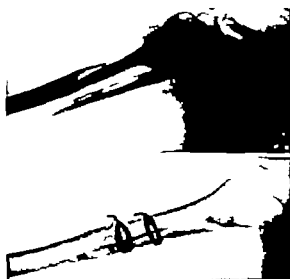


Fig. 10 above. Man aged 65. Spiral fracture of the humerus with complete separation of a large fragment of bone. Closed reduction unsuccessful because of interposition of muscles.

Fig. 11 Condition 7 weeks after operative treatment. The fragments were held in position by wiring.

4. When there is injury to a nerve or a vessel due to impalement upon a sharp fragment whose immediate closed reduction could not be accomplished.

5. In cases of transversely placed or interposed fragments of bone which must either be removed or replaced in their anatomically correct position. In fractures of the lower leg the fibula may constitute a hindrance to reduction. If the fragments

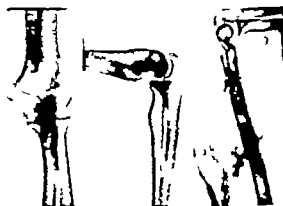


Fig. 5

Fig. 6

Fig. 17

Fig. 5 Longitudinal fracture of the lower end of the humerus with penetration of the elbow joint.

Fig. 6 Angulation and dorsal displacement of lower fragment.

Fig. 17 Ideal anatomical reposition was obtained by small dorsal incision and wiring.



Fig 18

Fig 19

Fig 20.

Fig 21

Fig 18 Comminuted fracture of the elbow in a man, aged 30 years, numerous fragments of the olecranon and the ulna with dislocation of the head of the radius.

Fig 19. Operative exposure by dorsal incision in the forearm opening of the joint, and wire suture through the olecranon. Fixation of the fragments of the ulna with 2 lateral metal splints.

Fig 20 Amount of consolidation of the fracture at end of 4 weeks.

Fig 21 Condition 10 weeks after operation. The fracture is firm, the individual fragments have grown together and the position of the joint is perfect. The buried splints were removed later.

of the tibia cannot be reduced and placed one upon the other because of interference from the fibula a piece of the latter must be resected.

6 In cases of transverse fractures of the upper arm and thigh in cases in which perfect position cannot be achieved by extension with Kirschner's wire or leucoplast etc. In this group should be placed also the oblique fractures and spiral fractures of the femur whose reduction is rendered difficult by the thick masses of muscle of the thigh. As a general thing one attempts to obtain

reduction with traction more frequently in the upper arm than in the thigh because the danger of operative injury is doubtless greater (injuries to the radial and the axillary nerves atrophy of the deltoid muscle etc.)

7 In fractures of the forearm. The relative frequency of inadequate consolidation in these fractures is well known. In this group pseudarthroses are most readily avoided by exact operative reduction if conservative measures do not succeed.



Fig 22

Fig 23

Fig 22 Fracture of the radius with separation of the epiphysis and dorsal displacement.

Fig 23 Small dorsal incision over the wrist joint, return of the epiphysis to position and fixation with wire suture.



Fig. 24, left 9 year old child oblique subcapital fracture of the neck of the humerus

Fig. 25 Operative exposure, fixation of the fragments with laterally placed metal splint firmly fastened with wires. Distinct callus formation. The fracture is firm at end of 6 weeks

8 In cases of delayed callus formation due to laceration of the periosteum or inadequate vascular supply as a result of laceration of the nutritive artery. In these cases operative freshening of the fractured ends may produce the desired results

9 In pseudarthroses (non-united fractures) Here operative intervention is the only therapy which can produce results

TECHNIQUE

As a matter of principle we operate upon fractures without the use of a tourniquet in order to avoid secondary hyperemia and hematoma. We prefer exact hemostasis in the tissues. Rapid incision through skin, fascia, muscle and periosteum is the most sparing to the tissue. Large incisions are necessary for the most careful exposure of the bone. In the thigh we prefer to place the incision on the lateral side at the anterior border of the musculus

tensor fascia lata. In the lower leg we use a longitudinal incision a fingerbreadth lateral to the anterior border of the tibia. In the upper arm we use either Langenbeck's resection incision or the Dollinger incision at the medial border of the deltoid muscle. Longitudinal incisions through the deltoid muscle may lead to atrophy and motor disturbances and should therefore be avoided. The soft parts are not held aside with sharp hooks but with blunt retractors. Care should be taken not to separate the periosteum from the muscle because this might result in nutritional disturbance to the periosteum and subsequent weakness of the callus

In the following we shall give a few cases which we operated upon in our clinic. Technique, indications, and results are shown more distinctly by a few examples than by statistical tables

Among the fractures of the lower leg we have (Fig. 1) a spiral fracture of the tibia with severe dislocation together with impalement and interposition of the muscles. Conservative measures were unsuccessful. Therefore two small metal bands were applied according to Parham-Putti technique. The condition before and after operation is shown in the picture

In many similar cases we have obtained fixation of the fragments by simply winding two wires about them

In fracture of the thigh we use different methods according to the individual case. In spiral and oblique fractures retention and fixation of the fragments can be obtained by wire suture applied after reduction to anatomical position (Figs. 2 and 3). If setting fails because of slipping of the fragments we must consider using splints of either autogenous or foreign material. As a general thing we do not approve of drilling through the bone and applying numerous screws, as some surgeons recommend. According to our opinion



Fig. 26

Fig. 27

Fig. 26 10 year old boy transverse subcapital fracture of the humerus

Fig. 27 Two metal splints are fastened with 3 wires over the site of the fracture. Because of the shortness of the proximal fragment simple wiring of the fracture would not



Fig. 28

be held, consequently three canals were drilled into the bone and the wires were passed through them

Figs. 27 and 28 show the position of the metal splints and the position of the fracture from the front and from the side

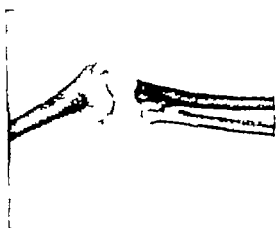


Fig 29

Fig 29 Patient was a girl 13 years old, who suffered a supracondylar fracture of the humerus with severe displacement and interposition of the soft parts. Large hematoma. Conservative measures unsuccessful in effecting a satisfactory union.



Fig 30

Fig 30 Lateral dorsal incision over the elbow joint, correct reduction of the greatly displaced fragments, fixation by application of metal splint firmly attached by wiring.



Fig 31

Fig 31 Removal of the splint and wire after 3 1/2 months. Very good anatomical position.

drilling through the cortex in a number of places and on both sides of the bones injures even the normal bone, and this injury would be all the more marked in a bone which has suffered a recent fracture and is in the process of destruction and regeneration. Therefore, in lateral splinting, we apply a new narrow perforated splint of stainless steel and fix it in position with 2 or 3 wires much the same as in simple wrapping with wire. You see a result of this treatment in Figure 6. This picture is of interest also because it shows a generalized osteitis fibrosa (Fig 4). You will see a number of foci in the right and left thighs. This same case showed fibrous bone foci in both upper extremities also. This 14 year old boy suffered a spontaneous fracture which you see in Figure 5.

In this case as shown in Figure 6, operative reduction of the fragments was done, fixation was accomplished by metal splint with wire sutures. The case is worthy of note because it shows that even bone with pathological changes healed with out reaction over the stainless steel splint which we used. We examined the boy half a year later. The fracture was firm and the foreign body was healed over with such complete absence of reaction that we decided not to remove it.

The metal splint technique just mentioned is especially successful in youthful patients with transverse shaft fractures which cannot be treated successfully with conservative extension therapy. In vigorous individuals however, even this splinting may be too weak for the strong musculature.

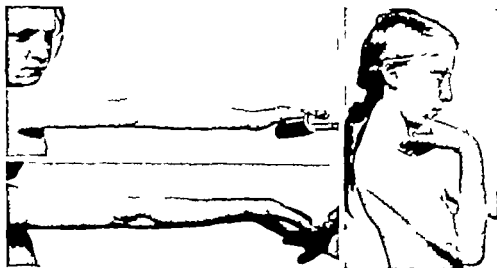


Fig 32 left, above. Complete extension in pronation.

Fig 33 left, below. Normal extension in supination.

Fig 34, right. Normal flexion.

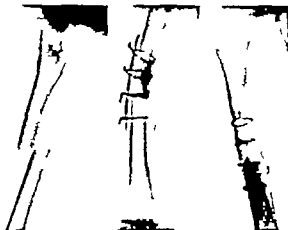


Fig. 35

Fig. 36

Fig. 37

Fig. 35 Transverse fracture of the thigh with inter position of muscular and soft parts in an 8 1/2 year old boy. Attempts at conservative reduction failed.

Fig. 36 Operative exposure of the fracture, attachment of a splint of bone from the tibia and fixation with 4 wires. Condition 6 weeks after operation, excessive callus formation, the plate is partly healed over at the upper end.

Fig. 37 Lateral picture, perfect anatomical position, large callus at the medial side of the shaft.

of the thigh. In such cases we prefer the stronger splinting by free autoplasmic transplantation of bone taken from the tibia. This method was developed by Lever. In our series of 12,000 fractures we have used it 75 times in the course of 7 years. It is important that the bone splint be of sufficient length and thickness and be fixed with absolute firmness to the fragments with wire. Figures 7, 8 and 9 show clearly the result of such operative repair in the thigh. The method can be used with excellent success in severely dislocated transverse fractures and especially in non-united fractures (pseudarthroses). Even though, in beginning pseudarthroses, freshening and drilling of the fragments (a method originally devised by Daeffenbach and recently revived by Beck) produces the desired effect, there are still numerous cases which will respond only to the bone splinting method just described. Absolute immobilization for 10 to 12 weeks is indispensable in these cases. Of course the foreign body must be allowed to remain longer in these cases because it fixes the bone splint. In most cases the wires become firmly embedded in the splint and in the parent tissue and heal over so that their removal is not necessary.

A further case showing the indication for wire suture in comminuted fracture is illustrated in Figures 10 and 11. A man, aged 65, suffered severe trauma resulting in spiral fracture with separation of a fragment of bone. The fracture

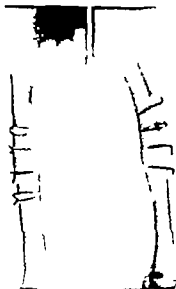


Fig. 38 Shows the condition of the bone after 8 months. Very good anatomical position of the femur, the fracture is firm, the plate of bone and the wires have healed over without reaction.

was sutured with wire and showed ideal position of the fragments 7 weeks later.

This is the case of a girl aged 21, who suffered a severe comminuted fracture of the upper arm (Fig. 12). There was a fracture in the middle of the shaft and another splintering comminuted fracture at the surgical neck of the humerus. Here neither extension nor other reduction maneuvers could produce good results. We therefore used an autoplasmic bone splint for the fracture of the shaft and impaction for the subcapital fracture of the humerus. The two control pictures (Figs. 13 and 14) show the anatomically perfect result after 6 years. The fractures are firm, the bone splint and the wire healed over without reaction and clinically there are no essential functional limitations.

The next case (Figs. 15 and 16) shows a longitudinal fracture of the lower end of the humerus involving the elbow joint. If such a joint fracture is not reduced to perfect anatomical position, it induces secondary arthritis deformans. For this reason operative reduction of the fracture was done. By means of a dorsal incision ideal position of the fracture and of the joint was obtained with only one wire suture. (Fig. 17—after operation in plaster.)

In the next case (Fig. 18) we have a severely comminuted fracture of the elbow joint. If such a case is treated by conservative measures there will be stiffness of the joint. Here the shattered



Fig 39

Fig 40.

Fig 41

Fig 39 Normal extension 8 months after operation.

Fig 40 Flexure of the knee joint after operation

Fig 41 Efficient functioning of the joints of the fractured lower extremity

elbow joint and the upper end of the forearm were opened by dorsal incision and the fragments reduced to the best possible anatomical position with the aid of 2 metal splints and wire sutures (Fig 19 immediately after operation, Fig 20, 4 weeks after operation, Fig 21 10 weeks after operation). The pictures show that the fragments became joined and are fixed in perfect anatomical position. The buried metal splints were later removed. The motility of the joint amounted to 60 per cent of the normal.

Figure 22 shows a fracture of the radius in which the entire epiphysis was split off and dislocated dorsward. If such a case is treated conservatively the wrist becomes stiff. Through a small incision one can bring the epiphysis back to the shaft of the radius and fix it there with a single wire suture. The perfect anatomical result is shown in Figure 23. Clinically the wrist showed normal function.

Bone fractures in children usually should receive conservative treatment, but there are cases in which even children's fractures justify or even demand operative therapy. During the last few years open reduction has been necessitated in many instances by the increasingly frequent serious traffic accidents which cause severe types of fracture such as formerly were hardly known. Mastery of the operative technique of fracture treatment makes it easier for the surgeon to make up his mind to operate even in youthful patients when conservative measures fail.

Figure 24 illustrates a transverse subcapital fracture of the humerus in a 9 year old boy. Here even the type of fracture shows that neither conservative treatment nor simple wrapping with wire could have achieved firm fixation of the fracture. For this reason (Fig 25) a metal splint was sutured upon the fracture and fastened with 2 wires. Anatomical position and function of the humerus were perfect.

In a similar case of subcapital fracture of the humerus in a 10 year old boy a variation of this technique was used. Three canals were drilled through the fragments and 2 metal splints were wired in place, one to either side of the humerus (Figs. 27 and 28). Fixation of the metal splints by means of drilled canals is necessary only in cases like this because if the wire were merely passed around the bone without a drilled canal the wire would slip off because of the shortness of the proximal fragment.

Supracondylar fractures of the elbow cannot always be reduced perfectly by conservative measures. If closed reduction fails, as in the case of this 13 year old girl (Fig 29) the fracture must be exposed and operative correction must be performed. In this case there was separation of the entire joint surface of the lower end of the humerus. It was attached to the shaft of the humerus by means of a metal splint and 3 wire sutures as you see in Figure 30. After 10 weeks the splint and wire suture were removed. Figure 31 shows a perfect anatomical reconstruction of the elbow joint.

and Figures 32, 33, and 34 show the ideal functional result (complete extension, complete pronation and supination, and maximal flexion)

Fractures of the femur in children, especially transverse fractures, may likewise fail to respond to conservative treatment as is so often the case in adults. In a series of 90 fractures of the femur in children which I reported in a recent article, there were 8 cases in which we were forced to use bone plating in spite of the youth of the patients; all were transverse fractures of the femur. Figure 35 shows the transverse fracture in an 8 year old boy. Figures 36 and 37 show the condition 6 weeks after operation with bone plate wired over the fracture. You see the end-result after 8 months in the next picture (Fig. 38). Bone plate and wires have healed over without reaction and the anatomical position may be designated as ideal. The normal functions of the thigh and of the joints are shown in the next pictures (Figs. 39, 40, and 41).

Of interest in all of these cases is the formation and resorption of the callus. As a general thing we may say that the poorer the position of the fracture the more callus is necessary for rebuilding the normal structure of the bone and the better the position the less callus is needed.

As you will gather from the facts just given, we may say that the results of the operative treatment of fracture are good. On the basis of my observations in 12,000 fractures in the course of the last 7 years and with the aid of various examples, I have given the indications for and the technique of operative treatment.

It is not our intention to minimize the importance of conservative treatment of fractures in emphasizing operative therapy. It produces equally good results within its realm of indications. But the difficulty lies in the exact definition of the limits of operative and non-operative methods. Only experience with a large number of cases can teach us when it is permissible to use the conservative method and when the operative method must be used. Neither of them is in itself the method of choice.

In art there are various styles; in surgery there are various methods. Both have an analogous purpose—the creation of a work of art. Neither style nor method in itself is good or bad. The

intuition and technique of the artist will create a masterpiece with any style, whether classical, baroque, or modern. With a correct grasp of the method which is indicated in the individual case and complete mastery of its technique the surgeon will be able to create a masterpiece with conservative as well as with operative measures.

BIBLIOGRAPHY

1. BOEHLER: Technik der Knochenbruchbehandlung 2d ed. Vienna 1930.
2. Idem. Zentralbl. f. Chir., 1933, p. 359.
3. BRASCHER: Zentralbl. f. Chir., 1933, p. 1366.
4. DANEL-IVANOFF: Acta chir. Scandinav. Stockholm, 1928, 63. Ref. Org. Chir. 42, 93.
5. DEMME: Operative Frakturbehandlung. Vienna Springer 1926.
6. DOLLINGER: Z. org. Chir. 1925, 40, 415.
7. FOELL: Zentralbl. f. Chir. 1929, p. 2631.
8. HENNINGSEN: Z. org. Chir. 1929, 45, 413.
9. HOFFMEISTER: Deutsche Ztschr. f. Chir., 1933, 240, 414.
10. JOSTA: Z. org. Chir. 45, 412.
11. KIRSCHNER: Technik der Knochenheft. Arch. klin. Chir. 1921, 121, 635.
12. KOTZCO: Abbau am gebrochenen Knochen. Arch. klin. Chir. 92, 46, 624.
13. Idem. Chirurgenkongress. Arch. klin. Chir. 1932, 62, 720.
14. LEXER, E.: Blutige Verwundung von Knochenbrüchen. Deutsche Ztschr. f. Chir. 1915, 33, 70.
15. LEXER, E. W.: Deutsche Ztschr. f. Chir. 1932, 236, 234.
16. MAGNUS: Chirurgen-Kongress. Arch. f. klin. Chir. 1933, Congress. Abzug, 1933.
17. MATTI: Knochenbrüche und ihre Behandlung. Berlin Springer vol. 10, 8.
18. MAY: Deutsche Ztschr. f. Chir. 1932, 236, 23.
19. OMBRO: Zentralbl. f. Chir. 1925, p. 915.
20. RIES: Fraktur und Muskel. Arch. f. klin. Chir. 1923, 1, 649. Arch. f. klin. Chir. 1934, Congress volume.
21. RUTGE: Arch. f. orth. Chir. 1926, vol. 24, Unfallstatistik.
22. SCHNEFFER: Beobachtungen bei einer fünfzigjährigen Frakturbehandlung 2d ed. Berlin Springer 1927.
23. SETSPON: Treatment of Fractures, 6th ed., Philadelphia and London W. B. Saunders Co. 1927.
24. Idem. Zentralbl. f. org. Chir. 1925, 45, 437.
25. WINCKEL: Ueber die Behandlung der Oberschenkelbrüche im Kindesalter. Arch. f. klin. Chir. 1934, 179, Pt. 5, p. 645.
26. Idem. Intravenöse Anästhesie für Fracturen. Anesth. & Anal. 1935, Mar.
27. WINCKEL and FALLER: Treatment of femur fractures in children. Internat. Clin., 1934, 11, 168.
28. WINCKEL and GIESCHKE: Reconsolidation der Knochen. Arch. f. klin. Chir. 1933, 177, 694.

FRACTURE OF THE (NAVICULAR) CARPAL SCAPHOID¹

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FRACTURES of the carpal scaphoids while apt to be very crippling to the individual unfortunate enough to have sustained one, have up to comparatively recent times received very little attention from general practitioners, X ray men and surgeons alike. Many of these wrists are treated either by the patient or by the doctor without an X ray, erroneously, as sprains, until too late to be given the proper treatment. The writer believes that these cases are worthy of more consideration and brings to the attention of those interested in this work a method of treatment that is apparently working out well, with a view to stimulating others to use it.

SYMPTOMS

This is one condition that "runs true to form inasmuch as most of the cases have almost identical complaints. Chief and foremost is pain at the site of fracture disability and pain on pushing limitation of dorsal flexion, local tenderness, and a marked weakness of the wrist as a whole. Occasionally there is a poor grip but this is usually the exception.

PROGNOSIS

From a clinical standpoint the unrecognized or tardily recognized fracture offers a progressively poorer prognosis in direct ratio to the length of time since fracture. Many in fact most of these cases are seen in the younger age groups and are most crippling, far more so than the average Colles fracture poorly treated or untreated. A group of 37 cases reported by the writer in 1929 from the Out Patient Department at the Boston City Hospital showed over 60 per cent to be 30 years of age or less. If bone absorption cavity formation and local irritation with new bone formation have started, it may be possible to check this by operating upon the scaphoid i.e. either removing part or all of it or by the grafting operation. It has been clearly shown by experience that the removal of the scaphoid has not produced a satisfactory result in all cases hence the resort to the graft. The cases with old fractures however offer a poor prognosis. These old cases are often crippling many of them giving a practically stiff wrist with chronic weakness and pain. In all fairness I think it can be said that in some of the recent cases good results occur with or without treatment and that in some of them progress is poor regardless of the treatment. In many recent

cases a very fine fissure fracture is often overlooked by physicians unfamiliar with them, and if not treated a heavy line of absorption is evident within a very few months. The following case shows this condition plainly

CASE 1. T. C. aged 34 years, laborer. Injured his wrist May 20, 1932 lifting a roll of paper. Roentgen films showed a fissure fracture and the patient was treated with anterior and posterior splints for 4 to 5 weeks with baling and massage. He was out of work practically 4 months. In July 1933 he was re-examined because of the condition of his wrist, namely pain, weakness, inability to push or to flex wrist dorsally. The film taken at that time showed marked absorption almost to the extent of cavity formation. Operation was advised, but the patient was unable to make up his mind.

Recent fractures seen early and properly treated do rather well as a rule. These cases, properly treated showing a poor result at the end of 3 to 4 months or more, should be operated upon at that time inasmuch as they will get progressively worse. In complicated cases with separation of the fragments early removal should give a favorable result.

TREATMENT

Recent cases in good position are best treated by immobilization and rest, with the hope that bony union will occur. There is considerable difference of opinion as to just how the hand should

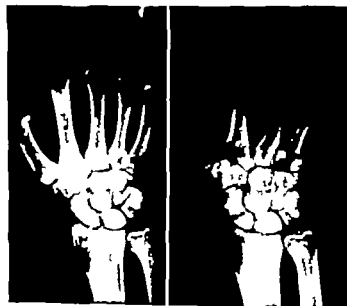


Fig. 1, left. T. C., May 20, 1932. Fissure fracture of scaphoid.

Fig. 2. Same patient, July, 1933, showing line of absorption with question of cavity formation.

¹Presented in the symposium on the Treatment of Fractures, before the Clinical Congress of the American College of Surgeons, Boston, October 10, 1934.

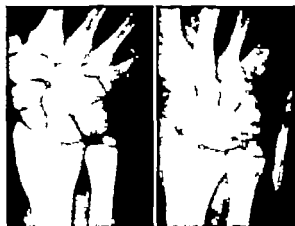


Fig 3 \ \ December 6, 1932 and December 20, 1932

be held at this time, many using the cock up position and many others using the reverse i. e. slight volar flexion with radial flexion. Many years ago while working with Dr. Cotton and Dr. Berlin this phase was studied at length and the conclusion arrived at that the cock up was preferable, this being particularly desirable in the event of stiffness of the wrist, the position of choice for an ankylosed wrist being in extension. Dr. David Berlin working on the cadaver has shown that the cock-up position gives better apposition. In putting these cases at rest the plaster-of-paris cast is used instead of the ordinary cock-up splint. This fixes the wrist, does not require adjustment when properly applied and insures the patient of a continuance of the treatment. Many times with the cock-up splint these patients give up the treatment at the end of 2 to 3 weeks and are never seen again.

Immobilization regardless of how obtained should be maintained for at least 6 weeks, followed by baking and massage for a few weeks. Too much emphasis cannot be placed on the need of 6 weeks immobilization, less time in my opinion being entirely inadequate. This is necessary to allow restoration of the blood supply and the healing of torn ligaments. The cast is applied in the cock-up position with slight radial flexion to include the palm of the hand and the base of the thumb but does not limit the motion of the fingers. Following the removal of the cast a straight splint can be applied for a few days or a flannel bandage applied and motion started at once. Most of these cases seen within the 48 hours following trauma will do well under this routine. The mistake most people make is to shorten the period of absolute rest.

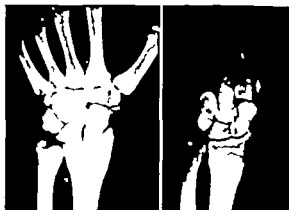


Fig 4 left Same patient, February 1933

Fig 5 Same patient, September 2 1933

Cases with marked separation or comminution of fragments should be operated on at once removing part or all of the bone.

The third group of cases now comes up for consideration and they represent the crippling ones that have had months of trial with the resultant pain and weakness so often seen. This group represents the cases treated or otherwise, and they are usually untreated or poorly treated, that have gone on to mal-union, cavity formation, bone formation along the radial styloid, to a definitely poor result. Men engaged in the heavy occupations requiring the use of the wrist continually are practically totally disabled. Some time ago many of the industrial surgeons were consulted for their opinions regarding the end results of removing part or all of the scaphoid. While some favored total removal and others partial, all agreed that the results were not too good and advised leaving the wrist alone if possible.

Dr. John Adams of Boston, so far as I know was the first one to resort to the graft operation for these cases. It was thought at first that this produced bony union but time has proved that the union is fibrous in many cases. However clinically this operation gives a good result in the few cases tried and should be used more extensively. The remarkable thing about it is that the patients are satisfied and feel entirely relieved from their previous symptoms. In performing this operation, I have grafted a piece of the tibia others make use of the radius on the same arm. Some men believe in the bone peg instead of the graft. The peg operation is much easier but I think that it does not stabilize the parts so well as the graft. Following the operation, the wrist is put up in plaster as above, i. e. dorsal flexion with slight radial flexion. This is kept on for 6 weeks, to be

followed by a straight splint for 10 days, meanwhile instituting baking and massage

CASE 2. N. Y. student, aged 17 years, injured his wrist in December 1930, and injured it again recently. December 1932 graft operation was done, plaster cast was worn 6 weeks, anterior splint 10 days. This boy also had an ununited fracture of the styloid of the ulnar. Figure 3 shows wrist before and immediately after operation. Figure 4 shows wrist 3 months later. Figure 5 shows wrist 9 months later. From an X ray point of view this case appeared to show bony union. Clinically the boy is extremely happy over the result.

At first the X ray films of these cases show what appears to be bony union but as a rule this bony union changes to one of fibrous union at the end of some months judging from experience with a few cases. Case 2, however at the end of 9

months shows what appears to be straight bony union.

SUMMARY

Results in the cases reported to date are much more satisfactory than those operated on by any other method. They require more time for convalescence but the anatomy is undisturbed and the patients themselves feel very much satisfied. They are entirely relieved of their symptoms. Believing that the usual procedure of removing part or all of the scaphoid has not given sufficiently satisfactory results to warrant its routine continuance another operation is brought to the attention of those working in this field. I believe that this graft operation is easily performed, does not change the anatomy of the wrist, and does give excellent results.

FRACTURES OF THE JAWS¹

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IT is indeed gratifying to have the subject of fractures of the jaw bones included in this symposium on fractures in general because there has been a tendency on the part of the surgeon to underrate their importance or to set them apart as lying exclusively in the field of the specialist.

The surgeon is being confronted with cases of serious injury of the facial bones more and more frequently owing to automobile accidents, and the proper management of such cases demands his earnest consideration. He is often unfamiliar with comparatively simple methods of fixation for fractures of the facial bones, consequently he is likely to pay more attention to repair of the overlying soft tissues leaving the fractures without early reduction and thus allowing secondary deformity to result. These facial injuries are frequently associated with shock, concussion fracture of the skull, or intracranial hemorrhage, and it is quite natural that emphasis on the more urgent complication should at times cause the facial injury to be more or less disregarded. Consideration for the life of the patient should of course be uppermost, but this should not prevent some attention to the facial injury at an early date in most cases. Early reduction and fixation are of the utmost importance here just as in fractures of other bones, since delayed reduction may result in malunion causing interference with function

and visible disfigurement. Delayed reduction also increases the tendency to infection because these fractures of the jaw bones are generally compound into the mouth. In fracture accompanied by extensive wound of the overlying soft tissues reduction of the fracture should be brought about first and the soft tissue wound closed afterward. Where the reverse procedure has been followed later reduction of the collapsed bone fragments may be difficult or impossible.

In reduction and fixation of fractures of the jaw bones the principle to be borne in mind is restoration of the original occlusion of the upper and lower teeth. Many surgeons following accepted textbook teachings and unfamiliar with really efficient and simple methods which utilize the teeth as points of fixation attempt to bring about the desired result by application of a Barton or other bandage. No amount of pressure with a bandage on the chin will fix a fracture of the mandible when there is any tendency to displacement and if there is no displacement no fixation at all is necessary. It would be just as logical to attempt fixation of a fracture of both bones of the forearm with a bandage alone. Sometimes the surgeon is tempted to try direct wiring or plating of bone fragments. This should never be attempted in recent fractures which communicate with the mouth since it only serves to add to the infection and never gives sufficient fixation

¹Presented in the symposium on the Treatment of Fractures, before the Clinical Congress of the American College of Surgeons, Boston, October 16, 1934.

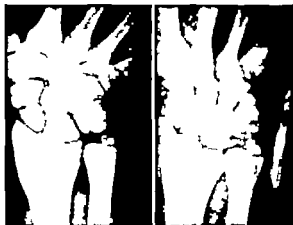


Fig. 3 N. Y. December 9, 1932 and December 20, 1932

be held at this time many using the cock up position and many others using the reverse i. e. slight volar flexion with radial flexion. Many years ago while working with Dr. Cotton and Dr. Berlin, this phase was studied at length and the conclusion arrived at that the cock up was preferable, this being particularly desirable in the event of stiffness of the wrist the position of choice for an ankylosed wrist being in extension. Dr. David Berlin working on the cadaver has shown that the cock up position gives better apposition. In putting these cases at rest the plaster-of-paris cast is used instead of the ordinary cock up splint. This fixes the wrist does not require adjustment when properly applied and insures the patient of a continuance of the treatment. Many times with the cock up splint these patients give up the treatment at the end of 2 to 3 weeks and are never seen again.

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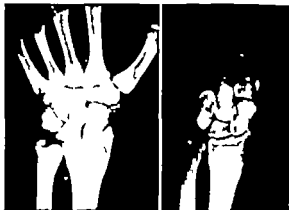


Fig. 4, left Same patient, February 1933

Fig. 5 Same patient, September 2, 1933

Cases with marked separation or comminution of fragments should be operated on at once removing part or all of the bone.

The third group of cases now comes up for consideration and they represent the crippling ones that have had months of trial with the resultant pain and weakness so often seen. This group represents the cases treated or otherwise and they are usually untreated or poorly treated, that have gone on to mal-union, cavity formation, bone formation along the radial styloid, to a definitely poor result. Men engaged in the heavy occupations requiring the use of the wrist continually are practically totally disabled. Some time ago many of the industrial surgeons were consulted for their opinions regarding the end results of removing part or all of the scaphoid. While some favored total removal and others partial, all agreed that the results were not too good and advised leaving the wrist alone if possible.

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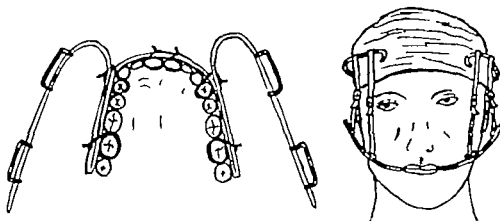


Fig 4. a, left figure, Heavy arch bar secured to teeth with wire ligatures for treatment of fracture of upper jaw b attachment of apparatus on upper teeth to plaster head cap holding upper jaw against base of skull

space for feeding. There are certain complicated types of fracture of the mandible requiring special methods of fixation. For information on these methods special works on the subject should be consulted.

Fractures of the maxilla are much less common than those of the mandible. They are often associated with extensive head injuries, fracture of the skull cerebral concussion, etc. There are no powerful muscles attached to the maxilla, consequently displacement of fragments is usually due to the direction of the traumatizing force though sometimes to gravity. Fractures of the maxilla may be unilateral or bilateral.

Unilateral fracture is usually caused by direct force coming from in front or from one side. There is a split in or near the median line of the hard palate and on the labial aspect the fracture line extends horizontally or obliquely backward above the level of the teeth. There are symptoms of contusion of the face and the entire maxillary dental arch on the side of injury is usually depressed. By gentle manipulation, mobility of the fragment can be demonstrated. Many cases can be successfully treated by pushing the fragment back in place until the teeth are in occlusion and then wiring the teeth of the sound side of the maxilla to those of the mandible.

Bilateral fracture of the maxilla is usually caused by direct force from in front or slightly to one side. This type is illustrated by cases in which the passenger's face strikes the steering wheel of a suddenly arrested automobile. In the majority of cases the entire upper jaw is displaced backward and sags downward posteriorly so that the upper teeth are posterior to the lower and only the last molars occlude, leaving a space between the incisors in front (Fig 3). The entire dental arch can be moved as a unit.

Fixation by means of the mandibular teeth is not advisable at first because of the mobility of the lower jaw. Support here should be obtained from the cranium by means of a head apparatus and reversed Kingsley splint. We have had made an emergency apparatus of this type which can be kept on hand in two or three sizes so as to be immediately applicable. It consists of a heavy metal arch bar to be secured to the outer surfaces of the upper teeth with wire ligatures and provided with arms extending out of the mouth on each side for attachment to a plaster-of-paris head cap with straps or heavy elastics (Fig 4). By this means the upper jaw can be gradually guided into position and after a week or 10 days when the upper and lower teeth have regained their occlusion they can be fastened together with wire ligatures for a period of 3 or 4 weeks until union is complete. Reduction of this fracture should be begun as early as possible, because if delayed too long union sets in and it may become very difficult to move the displaced bone by gradual traction. Correction of firm malunion in the upper jaw by operative procedures is generally not to be considered.

A brief consideration of fractures of the malar and nasal bones is not out of place here.

Fracture of the malar or zygomatic bone is always due to direct violence, and usually the breaks occur at or near its junction with other bones, the body of the malar being depressed and often impacted.

A depression is seen in the cheek on the side of the injury, just below the outer corner of the eye while lower down the cheek appears to be swollen. The entire side of the face may be so swollen and oedematous as to mask the deformity. Diplopia may be present, due to the depression of the floor of the orbit or interference with the action of

ocular muscles. Subconjunctival ecchymosis is seen. Epistaxis usually occurs, due to rupture of the maxillary sinus mucosa. The patient complains of numbness of the side of the nose and lip owing to infraorbital nerve injury, and often has difficulty in occluding the teeth owing to interference with the coronoid process of the mandible. Palpation reveals tenderness and irregularity of outline at 4 points: over the zygomatic arch, the junction of the malar with the frontal bone, the lower rim of the orbit, and where the malar joins the maxilla below. A ray examination made with the skull in the vertical position will outline clearly the depressed malar as compared to the normal side.

The depressed bone should be elevated as early as possible; neglect of this will result in a permanent deformity. Union in malposition occurs rapidly so reduction should not be delayed beyond 2 weeks. Many methods of elevation have been advocated. The most efficient in our hands is that suggested by Gillies which consists in lifting up the bone by a long flat elevator inserted through a small skin incision in the temporal region. The elevator passes through a slit in the temporal fascia and slides down on the temporal muscle beneath the malar. The necessary amount of elevation can be controlled by the fingers placed on the cheek. No fixation is necessary. The incision is closed with a suture, and leaves no visible scar since it is above the hair line.

Fracture of the nasal bones is also due to direct violence. The nasal bones may be thrust directly backward with or without comminution, the septum being crushed or buckled beneath them or the bones may be displaced to one side.

It is desirable to replace the bones if possible before swelling masks the deformity that is, within the first few hours after injury. If postponed for 2 weeks or longer union may require dislodgment with a chisel. Fractures with little or no displacement do not require treatment. In recent cases, it generally has been possible to elevate the depressed bones by pushing them up with a closed pair of curved Kelly forceps inserted in the nostril and molding with the fingers externally. The use of intranasal splints is not as a rule satisfactory, but the nose may be packed with gauze soaked in liquid petrolatum for 24 or 48 hours to maintain elevation and control hemorrhage.

Where the nasal bones tend to sag down a mattress suture of fine wire or silkworm gut passed beneath them through the skin from side to side and tied over lead plates resting on the skin will often aid in preserving the prominence of the bridge. Recent cases with lateral deviation also can be corrected by manipulation and recurrence of the deformity may be prevented by Blair's scheme of engaging the lower end of the nasal bone on the deviated side in a loop of fine wire passed through the skin, allowing the ends to pass down across the septum into the vestibule of the mouth on the opposite side and securing them to a molar or premolar tooth.

The main objects of this paper have been to urge upon the surgeon the desirability of early replacement of fragments in fractures of the facial bones, and to call his attention to the availability of simple methods of fixation quickly applicable without special dental laboratory technique.

ACUTE FRACTURES¹

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 Section on Orthopedic Surgery May Clinic

ACUTE fractures are true emergencies. Reduction is generally relatively easy within the first few hours after the accident before muscle spasm has become more or less fixed. Roentgenographic examination of any fracture is essential and only in unavoidable circumstances should it be omitted. Compound fractures should be treated as nearly as possible as one would treat a closed fracture reduction being accomplished at once if practicable. In this paper I shall not consider compound or open fractures as a separate entity but my remarks will be applicable in the main to both types. The open method of treatment should rarely be used for the correction of compound fractures.

DIAGNOSIS

Although the roentgenogram is pre-eminent as an aid in the diagnosis of fractures, it should not be relied upon to the exclusion of physical examination.

The wounded extremity should be carefully examined for abrasions of the skin and contusions, and for injuries to nerves, tendons, muscles and vessels. It is surprising how often musculospiral paralysis is missed at the first examination in fractures of the humerus, all attention being focused on the fracture. Manual examination and manipulation to establish a correct diagnosis is correct in theory but in actual practice it is seldom necessary for the roentgenogram gives much more definite information and makes painful manipulation unnecessary. Comparative measurements as to length particularly in the lower extremity should not be neglected.

With the aid of the roentgenogram it is possible to determine definitely the site of fracture—whether such fracture is in the shaft or in the region of the epiphysis or joint likewise can be determined whether the fracture is comminuted transverse spiral or oblique and whether the fragments are apposed, angulated or overlapped.

In the pioneer days in this country education was restricted largely to the rudiments euphoni-ously referred to as the three R's—Reading, Ratin and Rithmetic. We may without any such poetic license restrict the rudiments of the treatment of fractures to three R's also—namely Reduction Retention and Restoration.

REDUCTION

Writings on the treatment of fractures coming to us through many centuries have insisted almost universally on the necessity for early reduction. Early reduction however must not be practiced at the expense of thoroughness in diagnosis. Any hospital or individual accepting the care of fractures should see to it that the service provides both promptness and thoroughness, responsibility not being delegated to the inexperienced. The actual care of such fractures should be carried out or closely supervised only by those with sufficient training experience and by no means least interest.

The methods of securing reduction of fractures are legion, although fundamentally there are but three—namely manipulation traction and open operation. The result of any attempt at reduction should be definitely recorded with the roentgenogram, preferably also after the retentive apparatus is on.

There should be no quarrel between the closed and open method. It is much better if the open method is to be used to employ it in selected cases at once and not reserve it for use only after the closed method has failed.

Reduction of the fragments to perfect anatomical alignment as a guarantee of restored function is desirable but not always necessary for good function. In fact, insisting on such perfection may in some instances actually do more harm than good. In children it is surprising to see how an early result following reduction and retention of a troublesome fracture of the lower end of the humerus that is anatomically and functionally unsatisfactory in a year or two smooths out anatomically and gives perfect function. Fractures of the ankle without articular injury and in which there is a correct weight bearing line will return to satisfactory function even if the alignment of malleolar fractures is not perfect.

Intra articular fractures, especially if the functioning portion of the joint surface is involved may give particularly poor results and open operation helps but little because the displacement of the fragments is relatively slight and the condition can be improved but little even though the joint is opened. With such fractures much depends on the amount of crushing and actual destruction sustained by the underlying support



Fig 1 Comminuted trochanteric fracture before reduction



Fig 2 Trochanteric fracture reduced and retained by aid of two Kirschner wires

ing spongy bone. Hemorrhage into the capsule with subsequent fibrosis often leads to a tedious convalescence and in such cases the aim should be for early joint motion.

Whether or not the open method is to be used for any fracture will depend to a great extent on the individual surgeon—on his inclination, training and on the equipment at his command. While satisfactory reduction of a given fracture may be obtained by the closed method satisfactory external fixation and maintenance of alignment may be difficult to accomplish. If so the surgeon should not hesitate to use some form of internal fixation and thus avoid the dangers of precarious retention. The fact that external fixation must be used in addition to the internal fixation is no sound argument against the use of internal splinting. While I by no means advise open reduction of fractures as a routine method I value it highly and have used it often with benefit to my patients and with satisfaction and comfort to myself.

Those fractures which in my opinion are best treated by the open method are fractures of the patella, of the olecranon process, of both bones of the forearm of both bones of the leg and of the upper third of the femur. I am inclined to include also trochanteric fractures, fractures of the lower third of the femur with great displacement, certain fractures of the surgical neck of the humerus with marked rotation of the head and comminut

ed fractures of the head of the radius. Fractures of the clavicle, wrist, and ankle are best treated by the closed method as are also most of those of the lower end of the humerus. In many instances a fracture seen late, which might have been satisfactorily treated by the closed method soon after the accident, is better treated by the open method.

There is no valid reason why the open method should not be employed for fractures whenever necessary. So far as I know there has never been a fair presentation in the literature on the subject which would tend to prove that the open method gives poorer results in comparable cases than the closed method. The best report, that by the British Medical Association Committee as a matter of fact tended to indicate that the open method, all things considered, gave even better results than the closed.

RETENTION

Retention of the reduced and approximated fragments, often the greatest problem in the treatment of fractures, may be accomplished by internal means alone or in conjunction with some external means also. After reduction or locking of the fragments together and placing the limb in a neutral position with muscle pull balanced, retention is simpler because the normal muscle pull holds the ends of the bone locked. In a frac

ture of the humerus, for example, particularly of the upper third, muscle balance with the arm abducted (not beyond 45 degrees) tends to hold the fragments together after reduction, as does also the abducted position with internal rotation in a fracture of the neck of the femur. Plaster of paris with suitable padding affords the best material for external fixation, although splints, if used intelligently and skillfully, may be employed. Generally speaking splints should be retentive and not corrective. Ischemic paralysis due to venous stasis, especially in fractures of the upper extremity, is a dread complication, and it is by no means always due to tight dressings, for I have seen it develop when splints, bandages, or plaster had not been applied. Hemorrhage within muscular fascial planes may produce enough tension to cause ischemia. Prompt recognition of such a happening immediately followed by multiple small incisions to evacuate blood and relieve pressure will prevent the development of ischemia.

Traction, either skeletal or skin, is a great aid in retaining the fragments in alignment, as is best exemplified by the Thomas extension splint. The Thomas splint is a wonderful splint, but we often expect too much of it, for it is by no means automatic.

Open reduction and the use of some form of internal fixation of the fragments in my opinion has been found fault with too much. Metal plates and bands so often disparaged afford an excellent means of controlling difficult fractures and I never hesitate to use them when I feel the situation calls for internal fixation in closed fractures. It is a fine point of surgical judgment to determine when the open method is to be used in compound fractures, since at times it is necessary. Oblique and spiral fractures can often be held nicely by aid of several beef bone screws staggered through at different angles. If something stronger is needed, one or two Parham bands thrown about the fragments are reliable and easily removed when union is complete. I have practically given up use of the beef bone plates since to be of sufficient strength they must be large and heavy and they consequently are slowly absorbed and may remain as permanent foreign bodies. I prefer to use metal plates removing them when they have served their purpose. Autogenous bone grafts may be used for recent fractures but they demand an exacting technique which it is the privilege of but few to possess.

RESTORATION

The length of time that retention is necessary varies in different individuals and to a certain

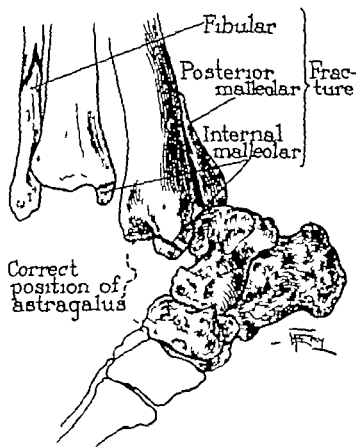


Fig 3 "Trimalleolar" fracture of ankle.

extent in fractures. The roentgenogram affords the best means of determining the amount of callus and its maturity. Discontinuance of the retentive apparatus is permissible only when callus has developed and aged sufficiently to insure development of bony union. Some such protective apparatus as a walking caliper should be used for fractures of the lower extremity in order to aid in bearing the weight, nor should this precaution be omitted without the consent of the surgeon in charge.

Truly a worrisome point is to decide the time when the fractured extremity may be used. If use is permitted too early, deformity at the site of fracture may ensue, which, if not promptly corrected, leads to permanent malunion. Excessive local tenderness over the site of fracture means an immature callus, and is a danger signal. Light massage and gentle active movements should be conducted without pain. If the fracture is kept in fixation too long, the muscles tend to lose their tone and elasticity and they undergo fibrosis, the fibrous capsule of the contiguous joints contracts, movements become painful, and convalescence is unnecessarily prolonged. With heavy people Pott's fractures of the ankle should be protected in weight bearing by slight elevation

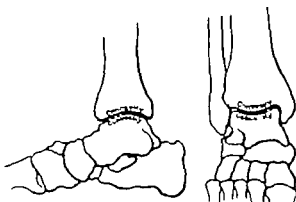


Fig. 4. Relation of concavity to convexity in antero-posterior and lateral views

of the inner side of the sole and heel by an inside T strap and by an outside iron to prevent valgus. Weight bearing should not be permitted in cases of fracture of the neck of the femur until bony trabeculations crossing the line of fracture can clearly be seen in the roentgenogram; this is evidence of union. A fracture of the shaft of the femur even though it seems clinically to be solid should always be protected by the use of a walking caliper until bony union is certain.

Massage and heat in some form are of undoubted aid. Active movements are better than passive movements because they promote increased circulation through natural stimulation. Passive manipulations are actually dangerous when left to the inexperienced.

TRIMALLEOLAR FRACTURE OF THE ANKLE AND RECENT FRACTURES OF THE NECK OF THE FEMUR AND TROCHANTER

The two fractures of the lower extremity that leave in their wake the most serious disabilities are certain fractures of the ankle and of the hip. I will again call your attention to one type of fracture of the ankle, which was so forcibly brought to our attention a few years ago by Dr. Cotton of Boston that it is known in many places as Cotton's fracture. It is a Pott's fracture with fracture of the posterior margin of the tibial joint surface causing posterior displacement of the foot. I choose to call it "trimalleolar" fracture of the ankle.

With such a fracture there is a tearing of the internal lateral ligament or fracture of the internal malleolus fracture of the external malleolus or fibula in the lower $3\frac{1}{2}$ inches (6.5 cm.) and fracture of the posterior tibial margin or posterior malleolus hence the term, "trimalleolar" (Fig. 3). The too common mistake is to correct only

the lateral displacement, leaving the astragalus displaced posteriorly. If the latter condition remains uncorrected it leads to permanent disability of no inconsiderable degree, and it is the one fracture of the ankle that should always be kept in mind. It rarely requires open operation and should be reduced as one would reduce an ordinary fracture of both malleoli, but care should be taken that the foot is brought forward and that the astragalus is replaced in normal position in the mortise between the malleoli. A good antero-posterior film of the ankle joint shows that there is normally a slight concavity in the upper surface of the astragalus, and into this should fit the slight convexity on the articulating surface of the lower end of the tibia. Laterally the opposite is true: there is a convexity on the upper surface of the astragalus which fits into a concavity in the lower articulating surface of the tibia (Fig. 4). If these two surfaces are seen to fit when viewed antero-posteriorly and laterally little attention need be paid to slight displacement of the malleoli.

The surgical bugaboo in fractures of the neck of the femur is non union. The old teaching that non-union should be expected in fractures of the hip has long since been discarded, largely through the teaching of Whitman and the adoption of his abduction treatment. Taken by and large, the Whitman method has given the best results thus far obtained. It remained however for a Boston surgeon to offer a method which necessitates an operative procedure but not necessarily a formidable one, and in my opinion promises a higher percentage of cures. Smith Petersen, by the use of his flange-nail, has afforded us, I believe, a most valuable method of treating these fractures and one that bids fair to give better results than any other method. I have offered a modification or an aid to his method which I found had also been advocated by Johansson of Gothenburg, Sweden, and King of Australia.

The difficulty in the use of the Smith-Petersen nail is in placing it accurately. The modification mentioned, which is shown in Figure 5 briefly is as follows. The hip should be reduced in the ordinary manner as advocated by Whitman, and anteroposterior and lateral roentgenograms taken to be certain that the position is correct. A Kirschner wire is then introduced through the trochanter neck, and head and a slight distance into the acetabular wall. Anteroposterior and lateral roentgenograms are taken to determine that the position of the wire is correct. If the position is not correct the wire can easily be withdrawn and re-inserted. When satisfied that the line of the wire is correct, a special cannulated

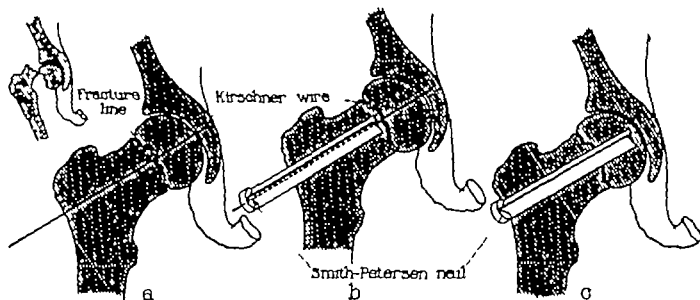


Fig. 5. a, Kirschner wire *in situ* through trochanter, neck, and head and into acetabular wall. Insert fracture before reduction. b, Smith-Petersen nail threaded over wire. c, Wire removed leaving Smith-Petersen nail in position.

Smith-Petersen nail is threaded over the wire and driven in. Another anteroposterior film is taken (or the fluoroscope may be used) and discloses whether the nail is safely embedded although it should not be so far in as to engage the acetabulum. This is the only untoward thing that may happen, because the nail must follow the wire. When it is determined that the nail does not engage the acetabulum the wire is withdrawn (Fig. 5) the wound closed and a plaster-of-Paris cast applied from the middle of the leg up to and including the thorax. The cast is split at the end of a week and movement of the hip begun. At the end of 3 weeks the cast can be removed and the patient allowed to be up on crutches. When roentgenological examination discloses bony union the nail may be withdrawn usually about 5 months after the operation.

Fractures of the trochanter in my experience unite readily although malposition with shortening is far too common and, contrary to the usual teaching, not easy to prevent. The most satisfactory method we have used is after reducing the fracture on the fracture table, to place two Kirschner wires at different angles through the trochanter and well into the neck (Fig. 1). This will steady the fragments and prevent their slipping while in the cast or extension splint. These fractures are often comminuted and far more extensive than appears in the roentgenogram, (Fig. 2), making it difficult to lock the fragments together firmly enough to prevent the strong pelvic thigh muscles from causing angulation. The wires used as pins prevent this and they are readily removed under local anesthesia when the fracture is united.

BONE GRAFT FOR NON-UNION OF THE CARPAL SCAPHOID¹

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WHEN a patient complains of a 'sprained wrist' with symptoms lasting more than 2 weeks, the possibility of a fracture of the carpal scaphoid should be considered and the necessary investigation undertaken. If examination shows a fair range of movement of the wrist joint in all directions, but limitation at the extremes of all movements, with tenderness in the anatomical snuffbox when the hand is adducted, and over the dorsal and palmar surfaces of the scaphoid with negative findings elsewhere, it is probable that there is a fracture of the scaphoid. If these findings persist for months or years after an injury causing symptoms in the wrist joint, the possibility of non-union of a fractured scaphoid should be considered.

X-rays taken of the carpal scaphoid in the anteroposterior and oblique directions usually provide the necessary evidence, but recent fractures may be difficult to see with X-rays taken in various directions. There are cases of recent fracture, easily diagnosed clinically in which the first roentgenograms do not show the lesion although plates taken a few weeks later will show obvious signs of fracture. Older fractures with non-union are seen more easily owing to the early rarefying osteitis and fibrous union, and later sclerosis of the adjacent margins of the fragments.

Fractures of the tuberosity always unite if the fragments are in apposition, and those through the intra-articular surfaces about the waist of the bone, which are the most common, may unite if treated. Johnson has shown experimentally that there is an adequate blood supply to the bone as a whole, and to both fragments, in case of fracture. He showed also that the type of reaction in fracture of the scaphoid is similar to that in other bones, but is more localized to the fracture line as there is so little periosteum to assist in the formation of subperiosteal callus. The formation of bone in the callus is slower than in other fractures.

Adams and Leonard say that untreated fractures of the scaphoid always result in non-union, and with the usual form of treatment a small percentage shows union. Grace supports this view with a report of cases showing a high percentage of non-union in those treated by immobilization for a period varying from 6 to 8 weeks. Boehler, on the other hand, states that most fractures of this bone unite if treated early by prolonged

fixation, and this agrees with our results. However, there are many injured wrists treated as sprains without fixation which provide the cases of fracture with non-union.

Certain anomalies should be kept in mind to prevent confusion in making a diagnosis of fracture and non-union. Ordinarily the center of ossification appears in the sixth year but there may be 2 centers and these may not unite but persist to form 2 bones. Rarely the os centrale may persist as a third bone.

Methods of treatment that have been advocated for non-union are excision of one or both fragments or of all the bones in the proximal row including the fragments of the scaphoid. Any one of those operations leaves a deformed wrist with some permanent disability in the form of impaired function and frequently with pain on active use of the hand (Grace).

If the individual with non-union of a fractured scaphoid is able to follow a sedentary occupation and avoid energetic use of the hand, he may have little discomfort but if his life includes heavy labor sport, or other strenuous vocation where full range of movement of the wrist is important, the best prospects are offered by a bone graft. There is a report of one case in which this operation was used, but the method has not come into general use. In our cases with non-union this form of treatment has yielded the best results. It is essential to have X-ray evidence that both fragments are viable and in apposition, and that there is no arthritis.

OPERATIVE TECHNIQUE

With the hand in full adduction a curved incision is made along the radial surface of the wrist joint extending about $1\frac{1}{4}$ inches upward and downward from the radial facet of the scaphoid. The ends of the incision are curved toward the posterior surface of the wrist, and the convexity anteriorly should reach the tendon of the abductor pollicis longus. The radial nerve and vessels and the abductor tendons of the thumb are retracted anteriorly the extensor pollicis longus tendon posteriorly. This provides exposure of the tuberosity of the scaphoid. A small transverse opening is made through the dorsal capsule of the wrist joint, exposing the dorsal surface of the radial facet of the scaphoid, and on this surface the fracture line is apparent. If the other bones

of the carpus have not been disturbed by the injury the fragments of the scaphoid will not be displaced, and in that case the fracture line is not disturbed by curetting, etc. After clearing the most prominent area of the tuberosity a small nick is made in the bone at this point with rongeurs, in order to provide for countersinking of the graft and prevention of bone proliferation which might interfere with abduction of the wrist joint.

With about a $\frac{3}{16}$ bit, a hole is drilled, beginning at a nick in the tuberosity through the proximal fragment, across the fracture line and into the distal fragment. Great care is necessary to line the drill properly, assisted by observations through the dorsal window so that no cartilaginous surface is damaged. The depth of the drill hole after

the fracture line is crossed should be measured every few millimeters to prevent damage to the semilunar facet of the scaphoid by going too far.

A suitable piece of cortical bone is removed from the tibia and shaped to fit snugly. It is passed well through into the medial fragment, care being taken that the fragments are not separated, and it is then cut so as to leave no projection. The dorsal ligament is repaired.

The hand is supported in a circular plaster in a cock up position for 8 weeks. All our cases in the General Hospital had X. ray evidence of bony union after this period, and within a few months the fracture line had disappeared. There was complete restoration of function, with a full range of movement in all directions without pain and with normal grip.

COLLES' FRACTURE¹

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THE subject of Colles' fracture, though admittedly well worn, presents many features of interest and importance to the surgeon whose field of practice embraces the treatment of bone and joint injuries. In hospitals where the segregation of fractures is an essential part of the surgical organization it should be possible to guarantee to all patients with a Colles' fracture a wellnigh perfect anatomical and functional result. But a considerable proportion—possibly the majority of Colles' fractures—must inevitably be treated under less ideal conditions. In Great Britain at least, (I am unable to speak for the United States of America) this common fracture of the wrist is still traditionally regarded as an injury which may be safely left to the sole jurisdiction of the family practitioner. Statistics obtained from large insurance companies relating to periods of disability following injuries of this type indicate quite clearly that the treatment of Colles' fracture, except in the hands of the expert, leaves much to be desired. On the other hand, we must appreciate the fact that even under the conditions of an organized fracture service, the mechanical difficulties encountered in the treatment of Colles' fracture in all its phases cannot be lightly dismissed. I believe that the quality of the work of any hospital fracture clinic may be judged best by the precision shown in dealing with these fractures.

The successful treatment of this injury calls for three essentials (1) a high degree of manipulative dexterity (2) accurate and uninterrupted control of the fracture throughout the stage of consolidation and (3) a knowledge of the fundamental principles concerned in the mobilization of an injured joint. Failure in any one particular will mean an indifferent or even a disastrous result.

ANATOMICAL AND CLINICAL CONSIDERATIONS

It is unnecessary to enter into a detailed discussion of the anatomical and clinical picture of a fracture which is familiar to every practicing surgeon. Certain facts, however, are worthy of emphasis.

1 In the first place *gross displacement* reproducing the characteristic dinner fork deformity of the older textbooks is relatively uncommon. But varying degrees of displacement obvious on inspection in most cases to the practiced eye, or clearly revealed in radiograms, occur in at least 75

per cent of the Colles' fractures seen in ordinary hospital casualty practice. It must be remembered that minor degrees of displacement become masked after some hours by the swelling due to the accumulation of the hematoma around the fracture line.

2 In my own experience the classical *triple displacement* of the lower fragment is present in a minority of cases. Either backward displacement *en masse* or radial deviation may be absent. In many Colles' fractures the deformity simply consists of a backward tilt of the lower end of the radius, which, when well marked, reverses the plane of the lower articular surface. In the absence of crepatus this deformity is frequently overlooked, in spite of the loss of the normal concavity of the lower end of the radius, which is so striking a clinical sign.

3 *Communion* is a factor to be reckoned with in many fractures, and the direct involvement of the wrist joint by a secondary line of fracture combined with spreading of the multiple fragments, adds to the difficulty of the problem of ultimate mobilization.

4 Disturbance of the *inferior radio-ulnar* articulation must also be considered. In not less than 50 per cent of Colles' fractures the fracture line on its mesial aspect reaches the upper limit of the articular facet for the head of the ulna, or enters the joint lower down. I have not been able to satisfy myself that involvement of the radio-ulnar joint in this fashion materially affects the function of rotation of the forearm, provided the injured joint is mobilized with discretion. Much more serious, however, is the disturbance which may result from a fracture of the ulnar styloid process at its base, or the equivalent injury—detachment of the fibrocartilage from the lower end of the ulna. As regards the frequency of this latter complication I have no statistical data, for clinical proof of its existence is rarely forthcoming. This point in the anatomy of Colles' fracture has exercised the minds of surgeons for many generations.

TREATMENT

Technique of reduction. In a recent fracture comparatively little force is required to effect a complete and accurate correction of the displacement of the lower fragment in all three planes. Reduction by manual pressure applied directly to the bony fragments, as taught by the late Sir

¹Presented at the symposium on the Treatment of Fractures, before the Clinical Congress of the American College of Surgeons, Boston, October 14, 1934.

Robert Jones, is, in my judgment, by far the most effective maneuver at our disposal. As an auxiliary force, traction applied via the hand has a distinct place—(a) in the early stage of reduction, to disengage the lower fragment, and (b) in the last stage, when the hand is brought into the position of palmar flexion and adduction. It should hardly be necessary to stress the importance of confirming the accuracy of reduction by radiograms. No radiogram should be passed unless the restoration of the normal plane of the lower articular surface of the radius can be convincingly demonstrated.

In neglected fractures manipulative reduction is a far more formidable undertaking but in my own clinic we are accustomed to correct a backward rotation deformity by manual force alone up to the end of the third week and sometimes even later. If this effort fails unless there is gross deformity, I believe the fracture should be left uncorrected. My experience in the results of open correction in Colles' fracture has been most disappointing. It must be obvious that after an osteotomy has traversed the region of the fracture accurate dovetailing of the serrated edges of the fragments cannot be achieved.

Technique of fixation. It is often taught that the method of fixation of any fracture is of secondary importance compared with the accuracy of reduction. In my judgment this is a dangerous doctrine when applied indiscriminately to Colles' fracture. In reading the writings of the older surgeons on this subject—which on the anatomy of the fracture are so illuminating—one is struck by the fact that many of the special splints introduced for the control of the fracture have been designed on unsound principles. After the effective reduction of a Colles' fracture the optimum position of the limb is with the wrist in moderate palmar flexion and the hand slightly adducted. This is a natural position of rest in which the structures on the flexor and extensor aspects of the wrist joint are in a state of reciprocal tension. I have little use for the position of extreme palmar flexion, which to me implies a confession of failure to disengage and correct the backward tilt of the lower fragment completely. Moreover, it is a sound principle that an injured joint should not be fixed for any length of time in a position of abnormal strain. I am also unable to understand the rationale of fixing a Colles' fracture with the wrist in dorsal flexion—a position which undoubtedly favors a recurrence of the backward tilt.

The essential factor in fixation of a Colles' fracture is the control of the *posterior* aspect of the whole forearm wrist, and dorsum of the hand

as far as the metacarpophalangeal joints. No standard splints, ancient or modern, can compare with a plaster-of Paris strip applied directly to the skin of the extensor surface. The plaster "gutter" should embrace not more than two-thirds of the circumference of the limb should be closely moulded over the lower end of the radius, and trimmed to allow free movements of the thumb. During the application of the plaster, and until its setting is complete, strong traction must be maintained on the hand by an assistant. At the same time the fracture is moulded between the thenar eminences of the surgeon. This enables one to ensure both the final correction of the backward tilt and the approximation of the multiple fragments where comminution is present.

Period of immobilization. Conflicting views are held regarding the length of time a Colles' fracture should be completely immobilized. In this connection I suggest that two guiding principles should determine our practice: (1) No Colles' fracture in which there has been an appreciable displacement is firmly consolidated before the end of the fifth or sixth week. (2) Every injured joint needs an adequate period of complete rest before being subjected to strain. In the treatment of elbow joint fractures in children the necessity for absolute rest is universally admitted, but in relation to the treatment of Colles' fracture there is no such unanimity. I am convinced beyond all doubt that the practice of immobilizing a Colles' fracture without interruption for a minimum period of 5 weeks is based on correct physiological and mechanical principles. During this stage the limb should not, of course, be entirely idle. Following the teaching of Boehler, the patient is instructed to carry out daily a regular scheme of activity in all joints of the upper limb except those which for the time being are securely immobilized, viz., the wrist and inferior radio-ulnar joints. For the greater part of this time no sling should be worn.

Experience in the treatment of Colles' fracture on a large scale has impressed me with the potential risks of recurrence of deformity, in spite of careful fixation. This tendency to secondary deformity is seen after the second week. It has been said with some truth that secondary deformation often represents a failure to obtain a complete reduction of the fracture at the time of the original setting. I am satisfied however, that in certain circumstances after a perfect primary reduction a backward tilt of the lower fragment may reappear at the critical period between the second and third weeks. For this reason it is wise always to check the position of the fracture by

radiograms after the second week. If the slightest change is discovered in the position of the lower fragment the plaster should be removed, the fracture remoulded and a new plaster applied. This is usually possible without anesthesia. Since the adoption of this routine in my own fracture clinic secondary deformity has become practically unknown.

Mobilization. On removal of the plaster gutter where the fracture has been immobilized without interruption for not less than 5 weeks, the excellent nutritional condition of the limb is always striking. There is no edema and all digital joints are supple and painless. The wrist and inferior radio-ulnar joints also allow a short range of movement without discomfort. Although in the majority of cases the patient may now be entrusted to work out his own salvation by active movements, he should not be left entirely to his own devices. The pace of mobilization should be determined by the anatomy of the fracture. Where there has been marked comminution, or involvement of the inferior radio-ulnar articulation, or where the wrist is the seat of a pre-existing arthritis, the joints should be allowed to take strain very gradually. Overzealous active mobilization in such circumstances may spoil the ultimate functional result. Forced mobilization in any fracture will be disastrous.

The services of a masseuse, except in a supervisory capacity, are redundant in a considerable proportion of Colles' fractures. But in many of the older patients, particularly those with ar-

thritic wrists, a judicious scheme of physical treatment is helpful at this stage.

RESULTS

Some years ago, when the subject of Colles' fracture had excited renewed interest among British surgeons, I was able to investigate the late results in 111 of the patients treated during the 1925-28 period in my hospital fracture service. The findings are shown in the table.

Result	Fractures without displacement	Fractures with displacement
Excellent (including perfect)	18	74
Good—that is, able to do original work, but some slight objective or subjective defect	6	10
Poor		3

In a more recent series of 200 consecutive cases treated under similar circumstances, the average period of total disability has been reduced to 8 weeks. These figures are in no way exceptional. I quote them merely to illustrate the quality of result which is now demanded from an organized hospital fracture service where there is unity of control.

It is the duty of those of us who are responsible for teaching the treatment of fractures in the medical schools to ensure that our students, both undergraduate and postgraduate, will be more competent in the future to handle a common injury like Colles' fracture with some degree of precision. We can do this only if our practice is founded on sound physiological and mechanical principles.

RECURRENT DISLOCATION OF THE SHOULDER¹

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THIS article is written because of the many inquiries regarding the operation for recurrent dislocation of the shoulder which the author first published in 1929.¹

The operation was worked out on the cadaver in 1926 in the dissecting room of the New York Post-Graduate Hospital. On the cadaver the head of the humerus could not be completely dislocated, even though all the muscles and capsule were severed.

The idea of the operation was obtained from an articulated skeleton in which the humerus was held in place by a metal pin, passed through the head of the humerus and attached to the upper angle of the glenoid fossa.

The operation is justified on the grounds of comparative anatomy. Dr Stockard called attention to the fact that in the dog the head of the biceps runs through the head of the humerus, and he was surprised that surgeons had not discovered this long before.

The following is the technique of the operation which I feel will give the best results:
1 The incision begins just outside the coracoid and passes downward for 3 inches in the line of the fibers of the deltoid.

2 The deltoid fibers are divided by blunt dissection. At this point the circumflex nerve and artery may come into view crossing the wound. Care should be taken to avoid injuring them. If the nerve is cut we get paralysis of the anterior part of the deltoid. Although this does not affect the outcome of the operation, it may be objectionable in women.

3 The tendon of the long head of the biceps is located by feeling for the bicipital groove. The transverse humeral ligament, which holds the tendon in the groove, is nicked with a knife and then with scissors. The tendon is exposed up to the shoulder joint. In this step of the operation cutting of the tendon may be avoided by not closing the blades of the scissors while splitting the capsule.

4. The upper edge of the tendon of the pectoralis major muscle is located in the lower angle of the wound. The tendon of the long head of the biceps is divided $\frac{1}{2}$ inch above this, after stay sutures of black silk have been placed in the proximal and distal parts. If this is not done, the

distal part will disappear under the tendon of the pectoralis major muscle, thereby prolonging the operation. The elbow is flexed about 45 degrees during this step and throughout the rest of the operation. The synovial membrane covering the tendon should be removed without fail, so that the tendon becomes fixed in the tunnel in the head of the humerus through which it is passed later.

5 By means of a $\frac{3}{4}$ inch long shank gouge a hole is made through the head of the humerus. This begins in the bicipital groove about 1 inch distal to the lesser tuberosity. The gouge should be so directed that it comes out on the articular head of the humerus in the line of the direction of the tendon, from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch from the edge of the articular cartilage. If it comes out less than $\frac{1}{2}$ inch from the edge of the articular cartilage, there is a chance for recurrence of the dislocation, because the tendon will not check the arm in extreme abduction. If fixed in the bicipital groove the tendon will not check the arm until it reaches from 255 to 280 degrees of abduction. This amount of abduction cannot be reached without dislocating the shoulder. The maximum abduction of a normal shoulder is 90 degrees and, combined with the scapular movement, the abduction of the shoulder reaches a maximum of 180 degrees.

6 The gouge is then withdrawn and the loose bone marrow is removed from its cavity. The gouge is reinserted and a flexible probe is passed through the tunnel from the proximal end guided by the gouge. The probe is threaded with the black silk which is attached to the proximal part of the divided tendon. The tendon is drawn through the tunnel and united to the distal part by means of the black silk which was passed through the tendon before it was divided.

7 The arm is abducted to a right angle and the transverse humeral ligament is sutured to that part of the tendon of the long head of the biceps which lies in the bicipital groove. This does two things: (1) It insures enough tendon from the head of the humerus to the glenoid cavity, thus removing any restriction of normal abduction and (2) it holds the tendon from moving up and down in the tunnel, and hastens its fixation in the tunnel.

8. The transverse humeral ligament and the capsule are sewed with continuous No. 1 plain catgut sutures the split deltoid muscle, with a

¹Nicola, Toufick. Recurrent anterior dislocation of the shoulder. A new operation. J Bone & Joint Surg 1929, 11, 1142.

Presented in the 29th exposition on the Treatment of Fractures, before the Clinical Congress of the American College of Surgeons, Boston, October 15, 1934.

few interrupted sutures. In women the skin is closed with skin clips or a subcuticular stitch.

9. The shoulder is then put up in a simple Velpeau bandage, reinforced with adhesive plaster with the arm close to the chest and the elbow flexed to 45 degrees. This position is maintained for 2 weeks. In epileptics it is wise to keep the shoulder immobilized for at least 6 weeks. If the operator chooses, the shoulder may be put up in the abducted position of 90 degrees, in a plaster of paris shoulder spica bandage. In 27 consecutive cases operated upon by the author the simple Velpeau bandage was used with excellent results.

10. The after-care may include radiant heat, massage and active movement, with the arm carried in a sling between treatments. In 9 of the 27 cases no physical therapy treatment was used. These patients made excellent recoveries with no prolongation of the convalescent period which ranged from 4 to 12 weeks. The 12 week convalescent period is to be ascribed to 3 compensation cases.

To date 37 cases have been done by the author with one recurrence. This recurrence was in a young man, who 5 months after the operation took a position as a camp counselor and caught a 10-pound medicine ball with his hands over his head. He felt something slip in his shoulder. I

believe that in this case the tendon slipped in the hole which passed through the head of the humerus. The tendon was not firmly fixed in the bone, and according to the operative note the synovial membrane surrounding the tendon was not removed. This should be done in every case to insure fixation of the tendon in the head of the humerus.

Three cases of recurrence of the dislocation have been reported to the author by various surgeons who have used this operation. In 2 of these cases the operator operated again. In one case the hole in the head of the humerus was too large, allowing the tendon to move up and down in the tunnel, thereby causing it to fray. In the other case the hole was not placed far enough on the articular surface of the humerus to check the head when the arm reached 180 degrees of abduction. These recurrences were due, therefore, to faulty technique.

CONCLUSION

The operation described can be used in all cases of recurrent dislocation of the shoulder whether the pathology be bony capsular or muscular. It is simple to perform, and leaves practically no restriction of motion. The convalescent period is short.

CONFERENCE ON TRAUMATIC SURGERY

INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY¹

FREDERIC A. BESLEY M.D., F.A.C.S. WAUKEGAN ILLINOIS

IT would appear that there is an ever increasing interest in this important subject of medicine and surgery in industry, and we take pride in believing that the educational program of the American College of Surgeons is a basic factor in this attitude. This is consistent with all of the broad educational policies of the College which have builded this organization into such a strong institution of learning, that it is comparable to a university in its influence which has made for better medicine and surgery for the patient.

It is clearly established that the executives in industry are becoming aware of the potentialities for financial gain through the scientific prevention and remedial measures applied to the care of the workers in industry.

The survey work of Dr. M. N. Newquist and Dr. E. W. Williamson upon which they have reported and upon which they will make further contributions, has shown some interesting facts, and it is gratifying to note the desire on the part of industrialists to secure the approval of the College for their medical organizations.

The policy of establishing a minimum standard by which the efficiency of medical organizations in industry can be measured, and approved when deserving is analogous to the standardization of hospitals which has resulted in that great advancement in the proficiency in the care of the patient which is recognized as one of the outstanding accomplishments of the College.

Insurance carriers who assume the financial responsibility for many industrial organizations, under the workmen's compensation laws, are likewise showing a keen interest in the activities of the College and are beginning to manifest an understanding of the financial importance of securing the most scientific and approved care for the injured. The question of financing the general medical care of the workers in industry is still paramount, and fortunately it is receiving broad consideration from many groups.

The Medical Service Board of the College has done an excellent piece of work in the formulation of their recommendations. It is believed that the

influence of their report will be most important in bringing about some readjustment in methods of payment which will enable the individual of moderate income to budget against the unexpected costs of illnesses of himself and his family. Obviously, the resultant sense of financial and of health security will be conducive to greater happiness and contentment.

The Board on Industrial Medicine and Traumatic Surgery has recently been enlarged by the Board of Regents, and it is our purpose to arrange for geographical groups through which more intensive activities may be carried on in given localities. The work of these groups will be correlated through the secretary at the central office. The influence of the sectional meetings as they are arranged by the College is recognized as most important and at these meetings there is evidence of a broad interest in the questions involved in the applications of medicine and surgery in industry. Obviously these meetings are splendid forums for the dissemination of the knowledge that we are acquiring and may we urge the Fellows of the College to take advantage of these opportunities to promote discussions of all phases of this important subject.

The formation of a committee of consultants in each hospital, the function of which is to have general supervision of the methods of treatment for all traumatic cases, is meeting with very satisfactory success and is doing much to improve the end results, because of the more approved and scientific treatment that is rendered. This work is being carried on by the hospital department and the increasing number of institutions adopting this plan is due to the energetic efforts of Dr. Malcolm T. MacEachern, who never loses an opportunity to promote the best interest of the hospital patient.

It is recognized that this whole subject of industrial medicine and traumatic surgery has many problems and many angles including educational features, financial questions, and, most important, the health, happiness, and contentment of the worker. Social unrest and radicalism is brought about by discontent. Healthy minds and sound

¹Presented at the Conference on Industrial Medicine and Traumatic Surgery during the Clinical Congress of the American College of Surgeons, Boston, October 12-19, 1934.

bodies are most essential in producing contentment. What could be more conducive to health in individuals by and large than the intelligent care of the mass of workers in industry? We pledge our best efforts to this end believing that we are loyally supported by every Fellow of the

College, without whose sanction and aid we could accomplish little.

May I express my appreciation of the efficient work done by our secretary Dr. Bowman Crowell, head of the Department of Clinical Research, who makes it possible for this work to go forward

THE PROGRAM OF THE AMERICAN COLLEGE OF SURGEONS IN INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY¹

FRANKLIN H. MARTIN, M.D., F.A.C.S., CHICAGO, ILLINOIS

THE Board on Industrial Medicine and Traumatic Surgery had its genesis during the World War. Traditions and theories were ruthlessly cast aside. It was necessary to execute tasks expeditiously and efficiently and with the greatest economy of management, money and man power. It was advantageous to the government to develop every facility that would preserve health. Hence a committee on industrial medicine was organized by the Medical Section of the Council of National Defense. Thus government planning and control demonstrated the economic and life-conserving value of a cooperative program such as the American College of Surgeons is putting into effect as a voluntary measure.

In a word, this program demonstrated as never before that the employer and the employee could accomplish most if they worked together harmoniously. The great leaders of industry of labor and of insurance composed their differences, to the great benefit of all concerned. This war experience was a progenitor of the Board under whose auspices this conference is being held.

In 1922 Dr. Daniel Z. Dunott convinced the Association of Railway Executives that railway employees would receive the most efficient care in hospitals approved by the American College of Surgeons. Forthwith by proclamation to the railroads, this association suggested that the employees of railroads so far as possible and practicable, should be treated in approved hospitals.

At the organization meeting of the Board on Industrial Medicine and Traumatic Surgery held during the Montreal Clinical Congress in 1926 an important first principle was recognized. The leaders of industry of labor of the insurance and indemnity companies, and of compensation commissions must harmonize their interests. And it is an outstanding slogan of the College that if we can convince the heads of these groups we will

be assured of the full, unqualified co-operation of assistants and associates.

The chairman of our Board, Dr. Frederic A. Beale, accompanied me to Washington on June 13, 1933 and we presented in detail the findings and accomplishments of the Board on Industrial Medicine and Traumatic Surgery to the head of the National Recovery Administration, General Hugh S. Johnson, and left with him an outline of a suggested code. His deputy administrator W. L. Allen, in charge of the hearings of the National Recovery Administration, read our suggestions, accepted them as a basis for consideration immediately dictated a suggested code covering our representations, and placed the two documents on file in his office for future reference.

A Minimum Standard for Medical Service in Industry has been perfected, and clinics which specialize in industrial medicine and traumatic surgery are under survey by the College to determine those which are equipped to give proper service. It is a stupendous task but with the support of the public—the employers and the employees—the economic saving will amount to millions of dollars, many lives will be spared, and thousands of potential cripples will be restored to perfect health. Leaders in industry have shown a deep interest in the basic study by the College of this important and far reaching problem. Obviously this is important for it furnishes the impetus for raising standards. Already 622 industrial establishments in the United States have complied with the minimum standard.

It is extremely important that all preventable health and accident hazards in industry shall be eliminated but it is likewise essential that diseases and injuries shall be properly diagnosed and treated. First and foremost, this will insure proper care to the ill or injured employee, and it will form the basis upon which diseases and disabilities may be reliably interpreted.

The liaison which has been established by the College between these various interested factors, and a knowledge of every circumstance which

surrounds the care of the ill and injured in industry, has placed the College in a position to aid in bringing about these beneficial, far reaching results.

A FOUR YEARS' SURVEY OF MEDICINE AND SURGERY IN INDUSTRY¹

M. N. NEWQUIST M.D., CHICAGO, ILLINOIS

DURING the past 4 years the medical departments or services of 1,122 industrial establishments have been personally surveyed by the American College of Surgeons. Of this number the medical services of 622 establishments, or 55 per cent of the total, have complied with the minimum standard for medical service in industry as formulated by the College and have been granted approval. I am pleased to report that in conducting these surveys, the College has received splendid co-operation from industry.

The campaign of the College to elevate the standards for medical service in industry is not only the practical application of its minimum standard for such service but it also represents a continuous study of the merits and defects of the various industrial medical services now in operation, in order that the data so compiled may eventuate in the proper constructive and remedial measures. The good features of the various medical services studied warrant recognition but they will take care of themselves. Let us first consider some of the defects which have been elicited by these surveys.

Defects in medical service in industry The major defect observed was that of inadequate medical or surgical supervision of health measures for employees and of sanitation of the plants. The provision of adequate medical and surgical service in industry today requires more than the skillful repair of industrial injuries. This is an age of prevention and the best way to deal with occupational diseases and industrial injuries is to prevent them. Medical supervision is absolutely necessary in order to secure adequate preventive health measures. Moreover, physicians and surgeons should be more than medical or surgical employees. By virtue of their qualifications they should be authorized to direct medical and surgical policies and procedures in the industrial establishments served by them. Adequate medical supervision will insure, first, adequate first aid and hospital facilities, second the elimination or reduction of accident and health hazards, and

third, the treatment of the ill and injured in industry by competent hands.

Inadequate medical supervision leads to inadequate medical service and it is largely for this reason that the College could grant approval to only 55 per cent of the medical services surveyed. During the past summer the College found in one industrial community alone over 90,000 employees who had been given so called pre-employment physical examinations by laymen. During the World War 7,000,000 men under 40 years of age were examined physically by medical examiners and 2,500,000 were found to be physically unfit for military service. The strenuous nature of military service naturally predetermines the rigid physical requirements which lead to the high percentage of rejections. In industry however, opportunity is presented whereby many of those afflicted with physical defects may be safely allocated to jobs that will make them self-supporting. In giving physical examinations to the army in industry, a trained medical examiner is the only one who is qualified to determine physical fitness for work. The solution of the problem connected with this situation is self-evident.

The records of pre-employment and periodic physical examinations of employees should be considered privileged communications subject of course to due process of law and as such they should be kept under medical responsibility and supervision. Only through the efforts of the unbiased physician or surgeon who guards the health and welfare of the employees as well as the interests of the employer, can these examinations and records be of mutual and of greatest value. Adoption of this principle will do much to reduce the opposition on the part of employees toward such examinations.

Surveys by the College have further revealed that in some industrial establishments nurses and first aid men are engaged in surgical procedures such as the suturing of lacerations. This practice on the part of industry is not only unsafe for the injured employee but it is illegal. The require-

¹Presented in the Conference on Industrial Medicine and Traumatic Surgery during the Clinical Congress of the American College of Surgeons, Boston, October 13-15, 1934.

ment by all states of a license for the privilege to practice surgery should automatically prohibit such practices by laymen.

The free examination of eyes of workers in industrial plants for the purpose of selling glasses has been observed to be a common practice carried on by commercial optical companies and by optometrists with the consent of the employers. The underlying commercial motivation of such service overshadows the benefits that might be expected therefrom. The College, through its minimum standard, has definitely gone on record as opposing the examination of eyes by any other than a qualified medical practitioner.

Finally, it has been observed that on account of inadequate medical supervision a number of industrial organizations have failed to institute recognized preventive health measures. In many instances this failure is due to the fact that the plant physician or surgeon has not been endowed by the official management with the appropriate authority to enable him to exercise properly his prerogatives. Of 925 plants recently surveyed by the College, only 7 per cent of the smaller plants had medical supervision of sanitation and general health measures as compared to 49 per cent of the plants having over 1,000 employees.

Rank of the medical departments in industry. The medical department should be an independent department co-operating with other departments within the organization but responsible only to a major official. In 925 industrial establishments included in our surveys, the plant physician was responsible to the personnel director in 41 per cent of the plants, to a major executive in 39 per cent, to the plant manager or superintendent in 17 per cent, and to the insurance carrier in 13 per cent. Most of the smaller industrial establishments have delegated the responsibility for the provision of medical service to the insurance carrier. Since our surveys to date have included comparatively few of the smaller plants, the percentage stated above relative to the insurance carrier should in reality be considerably higher.

Accident statistics. The National Safety Council has reported the following accident statistics for the United States for the year 1933:

Accidental deaths	90,000
Non-fatal disabling injuries	8,730,000
Occupational fatalities	14,500
Non-fatal disabling occupational injuries	1,555,000
Automobile fatalities	31,000
Non-fatal automobile injuries	1,685,000

That organization has further reported that the frequency rate of industrial injuries declined 58.8

per cent from 1926 to 1933 and the severity rate 39.4 per cent. Proper credit should be given to the rôle played by good medical and surgical service in this reduction. Investigation has revealed that an efficient medical and surgical service can be responsible for at least one-third of the reduction in the injury rates, while the safety service can be responsible for approximately two-thirds.

Studies made by the College have further shown that it is cheaper to pay for good medical service than to pay for disabilities. In a recent analysis of 334 industrial establishments, it was found that the smaller companies whose medical services were considered to be generally inadequate, had 39 per cent greater compensation costs than the larger companies where adequate medical service had generally been provided.

Workmen's compensation laws. All states have workmen's compensation laws with the exception of Arkansas, Mississippi, South Carolina, and Florida. During the past 4 years there has been a fortunate legislative trend toward the liberalization of the medical benefits for injured workmen. Several states have increased the medical benefits as to periods and amounts by amendments to their laws, while in some states the industrial commissions have arbitrarily liberalized the surgical fee schedule.

Eighteen states have state fund compensation insurance systems—Oklahoma having established such a fund in 1933. Twelve states have compensation laws covering occupational diseases either by a schedule of diseases or by blanket coverage. It is highly probable that many more states will make provisions for occupational disease coverage in their compensation laws within the near future.

CONCLUSIONS

In this presentation we have stressed the importance of the administrative or supervisory phase which is necessary in the provision of any industrial medical and surgical service. Industry is not handicapped by a lack of skilled physicians and surgeons in the country. Unfortunately however industry does not always provide the skilled medical and surgical service that is or could be made available. For this reason we urge those who are qualified in the field of industrial medicine and traumatic surgery to "chart the course" for industry so that the ethical standards and efficiency of its medical and surgical service may be such as to warrant the respect and co-operation of industry, of labor and the medical profession.

THE VALUE OF AN ORGANIZED MEDICAL SERVICE IN AN INDUSTRIAL ESTABLISHMENT¹

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President, Newport News Shipbuilding and Dry Dock Company

THE acceptance of the invitation to address the Conference on Industrial Medicine and Traumatic Surgery on 'The Value of an Organized Medical Service in an Industrial Establishment' was prompted by the author's years of experience in the shipbuilding and ship repairing industry. This industry makes use of practically all the trades common to heavy construction work, in addition to many peculiar to its own held. It employs the common laborer as well as the highly skilled mechanic. The opportunity to reduce its mechanical processes to a safe and standard routine is limited on account of frequent situations presenting new and unusual problems. The physical demands on the worker are heavy and the work generally is above the average in its hazards. It is doubtful if there is any other industry in which an organized medical service is more needed and its value more apparent.

In these days of high labor costs, management is impressed with the importance of the selection of the physically fit to insure productive capacity of a high order and of the reduction of all forms of waste to a minimum including the waste due to illness and injury of workers. Without a capable medical service, the management of a company cannot succeed in its attempt to establish and maintain these policies. Organized medical departments are the outgrowth of a long and real need for better service to the sick and injured in industry. Surveys of various medical departments have revealed the fact that compliance with the compensation law does not in itself signify an efficient medical service and further that financial awards cannot offset a disability that is chargeable to inadequate medical service.

As a result of these findings the American College of Surgeons has created what is termed a Minimum Standard for Industrial Medicine, which standard embodies the essential features for providing an adequate medical and surgical service. Compliance therewith will serve the best interests of the employer and the employee.

The objectives of our medical department are to learn by examination, the physical and mental fitness of new employees, to know work requirements and hazards in order to facilitate proper placement of workers to maintain and improve

the health and efficiency of those already employed to educate the worker in accident prevention and personal hygiene, and to reduce lost time and absenteeism due to illness or injury.

No medical examiner should be considered competent to render a physical examination with recommendations for placement in an industrial establishment until he has a working knowledge of plant activities, job requirements, and hazards. The task of examining new employees and deciding their physical fitness and their place in our company rests upon a graduate physician who has performed this work during the past 6 years. These pre-employment physical examinations, when made by a competent physician carry with them a safety element in that applicants are rejected who if employed, would be a menace to themselves to fellow employees, or to property. They are a direct benefit to the applicant in that they call attention to any remediable defect and further assist in placing the employee in the position for which he is best fitted.

The maintenance and improvement of the health and efficiency of those already employed is an objective that in its practical application works a great benefit to both employer and employee. The periodical health audit is the one most powerful factor that can be put into operation to attain this objective. There can be no controversy over the statement that in practically all instances the efficiency of a workman all other circumstances being equal, increases with his sense of well being. In connection with the attainment of this objective we believe that it is not only necessary to have capable physicians, but quite as important to have a capable nursing staff. Graduate female nurses are generally used in the clinics of the larger industrial organizations. By virtue of their training they are familiar with the principles of asepsis and antiseptics, they have knowledge of bandaging, they are already well trained in keeping records, they keep the clinic in a splendid state of cleanliness, and, finally, the white uniform has its psychological effect. These nurses command the respect of the employees, the kind, quiet manner in which they handle the sick and injured explains why there is no difficulty at our plant in having employees report to the medical department.

The education of the employee in accident prevention and personal hygiene is accomplished only by persistent effort. Coincident with the pre-employment physical examination our new employee is given a pamphlet, and he is directed to read it. This pamphlet includes many safety measures which in most instances, cause the reader to begin to think along safety lines. We employ a full-time safety engineer and an assistant safety engineer who work in close co-operation with the medical department and the industrial departments. Careful observation over a period of years is convincing us that 90 per cent of all accidents are caused by carelessness either on the part of the injured man or on the part of some other individual. Continuous efforts are directed toward making the plant a safe place in which to work. A spirit of competition has been built up between the various departments in an effort to reduce both the number and the severity of accidents. Records of the number of accidents per million hour working period and the degree of severity of accidents show conclusively that efforts made to teach men how to accomplish their work in a safe manner and efforts directed to make materials and machinery safe for men to work with, do bring about results. There is no end to a safety campaign. The personnel of industry is ever changing, the new man does not know so much about the dangers, and the old man has heard so much about them he is likely to become careless.

The reduction of lost time and absenteeism due to illness and injury is the most striking result from the activities of the well organized medical department. The frequency and severity rates are a fair index to the efficiency of the medical service. In many cases the safety of an injured man lies in the hands of the one rendering first aid. The duration of the period of convalescence frequently is in inverse proportion to the degree of thoroughness and correctness with which the injury is first treated.

It has been estimated that the prevention of infection alone would reduce the time lost from all ordinary causes by at least one third. It is obvious that the larger companies owe much of their excellent accomplishment to the fact that their organized medical services have kept the minor injuries from becoming major ones. This is accomplished in our plant by insisting that the employee report to the medical department with any injury no matter how trivial it may seem to him.

Accidents are not the only source of loss which involve medical service. It has been generally accepted that illness causes eight times as much absenteeism as accidents. The protection of the

employee against smallpox by vaccination, the administration of typhoid prophylaxis, are measures which by their institution promptly reduce the number of lost hours.

We believe the lost hours from injury and illness can be greatly reduced by real co-operation between the various departments in any plant. We have brought to a practical minimum the number of disgruntled patients by encouraging them to get back into the old stride as soon as possible, frequently giving them the simplest kind of work at the start.

Surveys show that many of the larger industrial organizations provide excellent medical service for their employees, but that much can be done to improve the service especially in the smaller industrial establishments. This comparative inadequacy is due as a rule not to a lack of skilled physicians or surgeons in the community but rather to a failure on the part of the smaller companies to provide early medical supervision and service and to select only competent physicians. The practical solution of this problem is the definite organization of a plan for medical service which will locate responsibility in competent medical hands. The most important step is the choice of a competent chief surgeon. Managements must choose men of ability of high ethical standards and if possible men with better than average personality. After this choice has been made the operation and choice of the remaining personnel of the department may be left entirely to the chief surgeon and the department will reach its greatest efficiency.

The personnel of our medical department is as follows: chief surgeon, assistant chief surgeon, 1 consulting eye, ear, nose and throat specialist, 1 consulting dentist, 3 graduate nurses, 1 secretary, 2 colored orderlies.

The equipment of our clinic consists generally of the following: operating room, X-ray room including a shock-proof X-ray with all fluoroscopic attachments, developing room and fire-proof storage space for filing films, dressing room, completely equipped physiotherapy department, 2 ambulances.

The records of the medical department are of invaluable assistance in placing and transferring employees and in determining when they should be retired from active service.

A well organized medical department in the plant performs a service over and above the saving of expense for it prevents the injured employee from getting into the hands of unscrupulous or incompetent lawyers and doctors, enabling the employee to retain all of his compensation, and

makes him better satisfied with his work and employer

The reports of insurance companies show that the medical expense for an injured employee is increasing tremendously resulting in higher insurance rates. A proper medical department in the plant is able to hold such an expense down to the minimum, as such a department is keenly interested in getting the injured man back on his job as soon as possible.

We have found after an experience of many years that it pays to have a properly organized and equipped medical department as an integral part of our organization. In fact, when operating under normal conditions with from 5,000 to 6,000 men, we believe that it more than pays for itself in reducing accidents, illness and lost time. In my judgment, it also results in the promotion of good will and a mutual protective interest between employer and employee

COME OVER INTO MACEDONIA AND HELP US¹

G. L. MARSTON BOSTON MASSACHUSETTS

Vice-President and General Claims Manager American Mutual Liability Insurance Company

MY title is a sudden inspiration, possibly reflecting a phase of a subject in which I have been vitally interested for many years. I could perhaps as well have captioned my talk, "Why are we not getting better end results in our industrial injuries?" I presume that a title of any address is more or less necessary if for no other reason than that it keeps one's listeners busy trying to connect the subject as announced with the discourse as delivered. I hope, however that my few remarks will be less of a discourse and more of a heart-to-heart talk on a subject in which we are all greatly interested.

It may be wise for me to state that I appear before you not only as a representative of my company but perhaps as an ambassador of good will without portfolio and representing the casualty insurance business as a whole. However that may be, time did not permit my securing authority from my associates of our Claims Executives' Committee to speak officially for them, yet I feel certain that nothing I shall say would not be heartily accepted by them.

For a little more than a decade we have been struggling to improve the administration and procedure of the most ambitious piece of social legislation ever enacted a system of compensating the workers in industry who might be injured without regard to the question of fault. The statutes relative thereto are known as workmen's compensation laws. Among the many provisions of these laws are the sections relating to medical care and the expense incident thereto. These medical provisions have many angles and the time allotted me will permit of only briefly alluding to one or two of these angles.

During the first years of our experience under the workmen's compensation laws, we found accumulating on our books a surprisingly large number of cases classified as permanent totals. A study of these cases revealed all too many of them as falling within the class of what you would call poor end results. What was the cause? What was the trouble? It is the speaker's personal opinion that this situation was due in large measure to the fact that it was almost impossible to interest the better grade of surgeon in industrial work. In considering this matter we must in fairness to all concerned bear in mind that in those days we were all dealing with a new problem and too much blame cannot be attached to anyone for the mistakes that were made.

A great deal has been accomplished but there is yet much room for improvement. The American College of Surgeons undoubtedly met with a considerable opposition from members of the medical profession when they set out by education to improve the standards of fracture service. Undoubtedly there was resistance also to the program of the College in respect to the standardization of hospitals, but notwithstanding that opposition such hospitals anxiously await the announcement from your College indicating whether or not they are upon the approved list. Is it beyond the realm of possibility that the College may some time in the not too distant future establish also suitable standards of qualifications which those who would practice in the field of industrial surgery must meet? Is it not possible that the College may even designate those upon whom they will set the seal of their approval as qualified to handle industrial injuries and act as

advisors? Your Board of Industrial Medicine and Traumatic Surgery under the able leadership of Dr. Beasley has established a minimum standard of medical service in industry which we heartily approve.

You have probably noted in your programs or in the public press an announcement by Dr. Beasley giving a skeleton outline of a program which has resulted from a conference held in New York between representatives of your College, headed by Dr. Martin Dr. Beasley and Dr. Newquist and the Claims Executives Committee of the National Council on Compensation Insurance, together with their medical directors. If carried out this program will mean a higher standard of surgery in the treatment of industrial injuries than we have ever known before. It will mean an earlier return to work of the injured man and a reduction of lost time and wages; the consequent reduction in compensation losses will lessen what is becoming almost an intolerable burden to industry—the amount of premiums paid, which after all reflects the losses. This, I believe is going to mean much not only to the injured man but to all the groups interested in the administration of the workmen's compensation law: the members of the medical profession as represented by your membership here, the industrial accident boards and commissions, as well as labor.

I wonder if you men have any idea of the tremendous sums that are expended every year for medical and hospital service. According to the report prepared by the National Council on Compensation Insurance, dated March 10, 1933, the compensation carriers represented in the National Council pay approximately forty million dollars annually for medical and hospital service, of which approximately six million goes to hospitals and thirty-four million is paid to doctors. A study of the medical cost trend from 1920 to 1929 shows an increase in the average cost per compensable case from \$77.00 to \$103.00; these figures being based on the experience of all carriers in all states over that period. These figures would be nothing to weep over if there had been a corresponding reduction in the compensation losses.

In a report of a special Committee of Claims Executives of the National Council who had given careful study to the question of the constantly increasing medical and hospital costs, it was found that much of the difficulty was due to the "treatment by unqualified physicians and surgeons, ending in poor surgical results, with prolonged disability and extended medical treatment over

treatment, including physiotherapy; padded bills; additional cost and inconvenience in transferring cases to specialists; and it was their opinion that the principal cure for this situation could be summarized briefly in the word education—education, first, of the injured; second, of physicians and surgeons and hospitals; and third, of industrial accident boards and commissions.

The importance of the physician in the whole scheme of compensation has perhaps never been fully appreciated. Not only does the physician receive directly approximately one-third of all compensation costs, many millions in amount as we have just indicated, but he is also largely responsible for the size of the other two-thirds. The rates of compensation, the schedules and benefits are fixed by law. Industrial accident boards and commissions can only apply the mathematics to the facts as they find them. It is the doctor who in the last analysis determines what the loss is both to the employee and to the employer. His skill determines the period of recovery and the extent of the recovery—in other words the end-result.

His conscientiousness and fairness determine the liability of the employer and the insurer. He is the great variable factor in this whole scheme and in this connection I come to the last thought that I want to leave with you and that is a situation which should have the serious consideration, not only of this body but of all state and county medical associations. I refer to the giving of evidence at hearings before industrial accident boards and commissions by men upon whom has been conferred the degree of doctor of medicine and who have been licensed by the state to practice as such—evidence which is neither scientifically reasonable nor scientifically probable. Such men are not only trailing in the dust the fair name of their profession but are dishonorably influencing awards by their false testimony.

May there be a better understanding between the members of your profession and the representatives of the casualty insurance business. Too frequently local groups on one side of the fence or the other (there should be no fence) antagonize each other by statements which do not reflect the real situation. The business of insurance has never been unfriendly to the medical profession.

It is the hope of the business of insurance that the vision which appeared to the Apostle Paul may appear to the Fellows of this great College and they may bear the words and answer the call "Come over into Macedonia and help us."

PAPILLOMA AND CARCINOMA OF THE BLADDER AMONG DYE WORKERS¹

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THE so called aniline tumor of the bladder is an entirely new occupational disease in this country, the first cases appeared in 1931, and the first report on a group of cases was made by Ferguson, Washburn, Anderson, Gay and myself. Since this first report (1) further studies by this same group with the very able assistance of Dr. E. E. Evans and Dr. Humphrey D. Wolfe, have materially increased the data on cases under observation and treatment.

Before presenting this later group I will very briefly review a few of the earlier investigations and attempt to give you a short description of the general nature of the dye manufacturing industry.

In 1895, Rehn reported the first observations made on a group of 45 men engaged in the dye industry in Germany. At that time he reported 3 cases of papilloma and 1 of carcinoma, and suggested the possibility of occupational origin. In 1904 he reported 20 additional cases.

Leutenberger in 1912 reported 18 cases which he had observed at Basel, and at the same time he reported, as a result of studying the statistics of the Basel Clinic, that 50 per cent of all bladder tumors treated at the clinic were among dye workers. Further, he proved that the incidence of bladder tumors was 33 times greater among dye workers than among those outside the industry.

Rehn's original theory brought about a great deal of discussion, much dissension and lengthy investigation. However his original opinion eventually became an undisputed fact. Bladder tumors were accepted as an occupational disease and made compensable in Germany.

Prior to 1914, practically the entire dye manufacturing industry was confined to Germany and Switzerland. Subsequent to 1914 the industry was developed in this country and has since grown to major proportions.

Briefly the manufacturing process may be divided into 3 stages, viz. chemical, intermediate, and dye. The first stage is a distillation process, and from the coal tar there is derived benzol, toluol, xylol and naphthalene. In the second, or intermediate stage, the products of the first stage are subjected to the processes of nitration, chlorination, reduction and sulphonation. In the third and final stage the dyes are compounded. It is in the second or intermediate stage that bladder

tumors develop and in no instance have they occurred in the first or third stages.

Since 1931, we have made 1,601 cystoscopic examinations and of this number there have been 1,173 individuals examined. 428 of the examinations have been rechecks. This entire group has been engaged in the manufacture of dye intermediates.

In this group we have found a total of 49 tumors, 35 of which are papillomata and 14 carcinomata. Thus, we have an incidence of bladder tumor in 4.1 per cent of the group examined. Deaths from cancer of the bladder as recorded in the United States Registration Area from 1925 to 1929 were 3.20 per cent (2). We have no figures indicating the incidence of bladder tumors in 1,173 individuals outside of the dye industries who have had routine cystoscopic examinations.

ETIOLOGY

The tumor producing chemicals are encountered in the intermediate stage of manufacture. A careful analysis of our group indicates that beta naphthylamine, benzidine and alpha naphthylamine are the causative materials. In Germany beta naphthylamine, benzidine, and aniline are accepted as the principal irritants. We have repeatedly examined a group exposed to aniline only for as long as 18 years, finding no tumor incidence, and therefore it seems possible that aniline is at least a questionable factor. English dye manufacturers have reported several cases from alpha naphthylamine and we can confirm this observation with a group of 12. The final observations have not been made and eventually other chemicals may be added to the list, but we can say that up to the present time beta naphthylamine, benzidine, alpha naphthylamine and possibly aniline are the causative agents.

Length of exposure varies from 5 to 23 years, the average being 11 years. German observers have reported 1 case in as short a time as 2 years. This case, however, is questionable, since there is no evidence to indicate that this man had a normal bladder when engaged for work.

Age does not seem to bear any direct relation ship to incidence. In our group the age range was 1 case 24 years of age, 9 from 30 to 40, 13 from 40 to 50 and 12 from 50 to 60.

Family history of cancer seems to be no factor for we were able to obtain a positive history in only 5 of our cases.

Absorption takes place by 3 routes: the respiratory, gastro-intestinal and skin. The most important route is undoubtedly the respiratory but it must be remembered that skin absorption of intermediates can under conditions of careless handling become the most important portal of entry. Further in view of the fact that tumor production is due to long continued exposure to low concentrations, even the gastro-intestinal tract may assume important proportions. One of the most important facts to remember is that after a minimum exposure of 2 years removal from occupation does not change the possibility of tumor development. Tumors have developed from 5 to 35 years after change of occupation.

PATHOLOGY

The pathological anatomy is essentially the same as in tumors of unknown origin. Tumors may occur as primary papillomata or may be malignant from the beginning. They may be single, multiple, papillary, sessile, infiltrating or non-infiltrating. The majority occur in or near the trigone, but may occur anywhere in the bladder wall. Metastasis is rare and in our group has not been observed.

SYMPTOMS

There are no reliable symptoms, either objective or subjective, to be ascertained without actually viewing the tumor through the cystoscope. Hematuria is a late symptom and often does not appear until malignancy is well advanced. Simple tumors may or may not show microscopical or macroscopical blood in the urine. Our routine requires a cystoscopic examination—of intermediate employees once a year while employed every 3 months in those cases which have been positive for tumor and prior to employment in all cases. German observers rely upon the presence of blood in the urine on 3 successive occasions to determine the necessity for cystoscopic examination. Our experience has convinced us that with this method many early cases progress into the advanced stages before detection. Many papillomata become carcinomata, and carcinomata may reach the stage where complete resection of the bladder is necessary with transplantation of the ureters.

TREATMENT

Treatment is divided into two divisions—preventive, and treatment of the tumors.

Preventive. The manufacture of dye interme-

diates must be conducted in such a manner as to absolutely exclude dust, fumes and skin contact. This means the adoption of an entirely closed process for the manufacture of alpha and beta naphthylamine, benzidine and aniline.

All applicants for employment in or about these processes must have a cystoscopic examination and before acceptance must present a normal genito-urinary system.

Treatment of tumors. Tumors classified as Grade I which are small and easily accessible are treated by bipolar fulguration through the cystoscope. Large tumors of the Grade I type are treated by open operation.

Tumors of the Grade II type, which are reasonably small and easily accessible are treated through the cystoscope by fulguration. Large and inaccessible tumors are treated by open operation.

All tumors of Grade III or IV are treated by open operation and implantation of radon seeds.

Our experience has convinced us that large tumors which are apparently benign may upon biopsy show sections which are definitely malignant. Furthermore, every tumor of the bladder can be considered malignant until proved otherwise by biopsy and microscopic examination.

The treatment as outlined is that which we have followed in the past 3 years. We have had only 2 fatalities, 1 case developing an acute retention 3 months subsequent to operation and the other developing a rectovesical fistula. The remaining patients are all back at work with the exception of one who was operated upon about 3 weeks ago.

SUMMARY

1. Bladder tumor is an occupational disease occurring among dye manufacturing workmen who are exposed to certain intermediates.

2. Time of exposure and not age is the causative factor.

3. Cystoscopic examination is the only sure method of diagnosis.

4. An absolutely closed method of manufacture will prevent tumor formation.

5. All tumors should be detected as early as possible and destroyed immediately.

BIBLIOGRAPHY

- GERMANN, O. H. Symposium on aniline tumors of the bladder. *J. Urol.* 1914, 31: 126-137.
- HOFFMAN, F. L. San Francisco Cancer Survey 1931. p. 176.
- LEUBENBERGER, S. C. Tumor formation as observed under the influence of the synthetic dye industry. *Beitr. z. klin. Chir.* 1912, 80: 208.
- KIMM, L. Tumors of the bladder among factory workers. *Arch. klin. Chir.* 1895, 11: 583-600.

BACK INJURIES¹

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BACK strain is a subject one hesitates to speak on, so cumbered is it with difficulties in diagnosis, with wild theories of pathology and with divers methods of therapeutic procedure. The fact is that, save for certain specific lesions, we know very little about backs—hardly enough even to draw the line between pathological conditions and those due to actual trauma or continued slight overstrain. We can name certain definite pathological cases, such as the Strumpell Marie type with ankylosed vertebral bodies, and the infectious type with progressive fusion of sacro-iliac articulations, in which trauma is an exciting and not a producing cause. Similarly, spondylolisthesis or pedicle defects indicate no recent cause although they may be a source of aggravation.

In definite traumatic cases there is no question about the fractures, whether they be of the unimportant transverse process or of the vertebral bodies, for they are of recent origin. However, the differentiation between an old compression fracture and the occupational wedge-shaped body (Lane) or changes sometimes seen in elderly patients with hypertrophic changes, is a source of argument.

The occurrence of lumbosacral lesions without pedicle defect or spondylolisthesis is debatable, as are also many sacro-iliac cases. It must be confessed that our diagnosis between lumbosacral and sacro-iliac lesions is clinically far from being precise.

There are sacro-iliac cases obviously involving displacement, usually in flexion that are not shown in the X ray, but in which brilliant results from manipulation leave no diagnostic doubt. In all other lumbosacral and sacro-iliac cases, unless secondary changes such as porosis or cartilage absorption are evident we have no proofs—and as a result we are often wrong in our diagnosis. There are elaborately worked out tests for differentiation but they do not seem to work out very well. Perhaps to clear the decks, we should consider the lesions as to which we have actual data.

First let us consider fractures and that means compression fractures from the tenth dorsal to the second lumbar vertebrae. These fractures show clinical localization of symptoms even if there is no obvious deformity. The skiagraph is—in fresh cases—unmistakable.

Treatment is under question only as to whether we should attempt forcible correction of the compressed vertebra or not. With or without this treatment we must attain hyperextension and hold it. Bed treatment for a month followed by a brace and the indicated exercises usually results in a cure in 6 to 9 months. These patients do almost uniformly well if they are so treated.

Fractures of transverse processes often multiple, seem to be usually the result of convulsive muscle action and are in themselves unimportant. Union often by fibrous union only. They seem to be only a complication and a visible evidence of a badly wrenched back.

Rupture of cartilages, now talked of, does occur. How important it is is doubtful, but for the next year or two this lesion with the migration of the much advertised nucleus pulposus will possibly make much legal trouble. How important it is clinically is *sub judice*.

There is no doubt that lumbosacral lesions are overlooked. Congenital lesions, whether full-blown spondylolisthesis or pedicle defect only may give no trouble for youth and early manhood, but may make trouble after trauma. These lesions and few others call for spinal fusion. The difficulty is to make a diagnosis and that depends on excellent X rays. In absence of this definite diagnosis indiscriminate fusion operations are not called for, whereas they have frequently done much harm.

Similarly fusion operations higher up can be justified only by very definite local signs indicating ligament tear or damage to articulations or the like which are seldom definitely shown. Lately we have heard more than a bit about asymmetry of articular facets and the resulting strain.

Most of the back cases seem to be strains of muscle or ligament, tending to hang along lame for months. If treated with absolute bed rest in case there is irritative spasm, and with brace support for a few weeks then with careful exercise following this, most of them will get well. In some cases there is a toxic background calling for the search for foci of infection.

Commonly enough there is an actual pathological arthritis of infectious type. Frequently there is an obvious overgrowth—"hypertrophic arthritis"—which is in fact hardly more than the badge of age or hard work. While the latter condition does not always determine a bad prognosis it does

give a poorer slower comeback after trauma.

Very rarely there are sacro-iliac joints that crunch in and out of place. These are the cases, perhaps the only ones, calling for fusion. There are others in which careful history taking and examination leave no doubt of a displacement, usually in a position of flexion. These are the cases for reduction by extension manipulation. When treated, they do as well for us as for the osteopath and furnish spectacular cures. They cannot be diagnosed by X-ray.

As to other sacro-iliac conditions the picture is very confusing. Cases showing the so called clinical signs evidence no displacement, and if there is a pathological condition present it is apt to be one of porosis about the joint or later sclerosis

more suggestive of arthritic change than of trauma.

Acute cases, apparently sacro-iliac conditions with referred sciatic pains, often with exaggerated muscle spasm, yield with fair constancy to rest in hyperextension, belt support, and careful exercises. What the pathology is we do not know. It seems that the more radical measures of fusion of various sorts have shown no encouraging results.

Knowing as little as we do of the pathology of the usual strains, it is well to proceed conservatively unless an actual diagnosis indicates otherwise. After all, many back injuries fall in the category of what our colored brother calls "mishery in de back" and they do well if they are not over diagnosed and overtreated.

RECONSTRUCTION SURGERY—THE REPAIR OF SUPERFICIAL INJURIES¹

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AS under the term of reconstructive surgery almost any form of plastic surgery other than cosmetic might be included, the subject would require a complete treatise to do it justice and as it is one's experience, whether good or bad which might be of some use to the profession, it is proposed to base this paper on personal experience. All surgery is reconstructive, even though its main primary object at the time be destructive.

CLASSIFICATION

Group 1 Many general surgical operations are plastic in character but a true plastic operation may be defined as one in which new tissue either in the form of a graft or flap is introduced.

Group 2 Many cases of injury to the face are typified by a displacement of normal tissues without true loss of substance, such as in broken noses and jaws. In this group the main treatment consists in reduction of the fracture, and replacement of the soft tissues and only in the severer cases is a graft required. It is obvious that accidents of work, transport, and home life are likely to produce injuries falling under Groups 1 and 2.

Group 3 Those 'plastic' or cosmetic operations which involve reduction of existing normal tissues or additions to them are definitely in a different category and may on this occasion be dismissed.

THE CAUSATIVE AGENCIES AND THEIR RELATIVE FREQUENCY

Group 1 cases require the introduction of new tissue by means of a graft or flap. Burns form the chief causative agent of the injuries, and those occurring in the home are still the most prevalent—clothes catching fire, scalds, hot water bottle burns and burns acquired during epileptic seizures being the most frequent. Other common causes are burns due to the explosion of spirit and paraffin lamps, to the ignition of celluloid combs, and the explosion of petrol due to static electricity during the dry-cleaning of clothes. Burns associated with other injuries resulting from accidents in motor cars, motor cycles, motor boats, and aeroplanes are only too prevalent. The accidental explosion of acids in chemical works, criminal

cases of acid throwing and gunshot injuries both accidental and intentional are causes sometimes met with. The electric burn not infrequent, presents distinctive features. Industrial injuries other than those resulting from burns include crushing by machinery and scalping accidents now less frequent since hair has become shorter, and inspectors more vigilant. Mining accidents from falls and explosion must also be included. Large losses of the skin of the face and body may occur as the result of road accidents. Injuries to the eye, apart from the eyelids occur as the result of flying pieces of hot metal or acid, and fragments of glass, these may cause ulceration of the conjunctiva and subsequent symblepharon.

Injuries of the face causing displacement of normal tissue, *Group 2*, are most frequently the result of accidents of transport. Soft tissues are cut, crushed, and displaced while the bony and cartilaginous framework of the face may be fractured and displaced by these very common injuries. A large number of these displacement injuries also occur as the result of sports, such as boxing, football, cricket, riding, polo, hunting, skating, aviation hockey, lacrosse and even golf. The same type of injury may also occur, but less frequently, in the factory and the home.

DIAGNOSIS

For a successful outcome of the treatment, an accurate diagnosis must be made. This point is emphasized because few surgeons have been trained to estimate by eye the exact loss of skin, muscle, bone or cartilage that may occur, or indeed the amount of displacement of normal tissues. But it is on these very points that the diagnosis for the reconstruction mainly rests. Further, loss cannot accurately be estimated until allowance has been made for the replacement into normal position of those parts that are normal but displaced.

TREATMENT PLAN

Having made this estimate one must then decide on the best method of repair, and if the method of choice be not available which of the various alternative methods should be attempted in any individual case, taking into consideration the age, sex, physical, and financial condition of

TABLE I—FREE GRAFTS

Type (Fig. Nos.)	Donor area	Recipient area	Method	Author's references
<p>Skin grafts</p> <p>Thin rasor grafts are generally taken from the inner side of the arm where it is hairless (Thiersch grafts) (Fig. 7)</p>	These grafts are generally taken from the inner side of the arm where it is hairless	Thin rasor grafts are usually used in places where mucous membrane is normally present, as in the mouth, eyelid, buccal sulcus, or cutaneous grafts for contracted sockets in the eyelids	Instruments used, Blair or Thiersch knife, stretched, heated and vaso-line, the heated blade used to keep the skin at even stretch. The graft is cut as thinly as possible. Graft applied on "stret" model with pressure	1, 2, 3
Thick rasor grafts	The inner side of the arm or any aspect of the thigh or back. Immense pieces of graft can be cut with Blair or Thiersch knife	The most common conditions in which these grafts are used are granulating areas of the scalp and forehead, ocular and retroperiorbital ectropion of the eyelids, V-ray burns of the face and neck, and loss of whole skin on the body or limbs. They are particularly applicable for replacement of skin on the hands, for webbed fingers, X-ray and other burns	Same as for thin except that the graft is cut considerably thicker. Graft applied on stret model with pressure	10
Detached grafts (eyelid thickness grafts)	The inner side of the arm, front of the chest, outer aspect of the thigh, the back of the ear and upper eyelid	Eyelids, and portions of the face in which good cosmetic effect is specially worth attempting. When successful, they are more flexible and of better texture than rasor grafts, but the percentage of perfect success is not as great as with the thick rasor grafts. Indications for use where there is ocular ectropion of one eyelid, and not of the opposite eyelid, enough skin may be successfully freed to repair the ectropion eyelid. Skin from the back of the ear can usually be obtained, and is useful for eyelids, loss of skin on the nose, and other small patches on the face	The skin is excised in horizontal dissection, down to, but not including, the fat. The graft is cut to such size and shape that when it is sutured into place it will be at the tension of normal skin—as other words, as exact fit. Pressure applied	
<p>Hair-bearing grafts</p> <p>There are also detached grafts. Care must be taken to include all the hair follicles</p> <p>Patch grafts</p> <p>Mucous membrane grafts</p>	<p>The mastoid strip</p> <p>The thigh</p> <p>The mucous membrane of the lower lip and inside of the cheek</p>	<p>For eyebrows and mustache</p> <p>On granulating wounds where cosmetic effect is not imperative</p> <p>In cases are almost entirely caused by loss of connective tissue, when there is normal epidermis, and particularly in symphysis to form the lining of new eyelids. They also may be used in the eyelids</p>	These grafts are usually detached, but may be skinned with a rasor. They are usually cut to the size of the part to be replaced and sutured in place. Even the thinnest skin graft is likely to grow sufficient hair to replace an existing eye	4
Fat grafts	Fat is usually obtained from the abdominal wall, and frequently from the area of an existing scar. The fatty firm will not bulk be absorbed on grafting	The commonest application of fat method is for bulking up the contour of the cheeks or chin, or for injection beneath previously implanted skin graft. They may also be used under depressed scars	A piece of fat is cut to the shape required and about 30 per cent larger than finally required to fill the defect to allow for shrinkage. It is then inserted underneath the depression	5
Cartilage grafts (Figs 8 and 9)	<p>(1) Costal cartilage. The free border of the seventh rib is usually taken, as it is the thickest and straightest possible</p> <p>(2) Septal and alar cartilages and the cartilage of the concha may of great use for minor deformities of the nose</p>	<p>Chinify the bridge of the nose</p> <p><i>Remable.</i> A curved piece of ear cartilage may be used to give support to a new skin nose, or new eyelid. Large pieces of ear cartilage may be utilized to give form to a new ear, but this type of graft usually has to be taken from donor</p>		6
Osteochondral grafts	The portions of the base and cartilage in the rib may be utilized with success to form new bridge in the nose, the bony portion being sutured to the freshened bony portions of the existing nasal bridge	Generally of value in young children's noses. Osteochondral grafts may be used to replace the premaxillary ridges of the body of the nose after surgical removal of that area, the cartilaginous portion, inserting into the glacial cavity region and forming a false point there		
Bone grafts	Usually the ilium	This is the usual method of repairing new bone in the maxilla, though block ilial grafts have also been used. Osteoperiosteal grafts from the tibia have also been used with success in making a new mandible		

*Cases will occur from time to time in which completely detached portions of the face, and fingers or feet, in particular, are brought up with the patient, having been retained and carefully preserved in the hope that the doctor might be able to reattach the portions. From a strictly logical standpoint of the type of case, it is very definitely recommended to attempt the reattaching. The illustrations are appended of an extreme case in which the tip of the nose was cut off by a piece of glass and sutured back into place 10 hours later. In a dog bite case portions retained and sutured from the dog or the ground were reattached, successfully enough to obviate further treatment, in the third, large portions of the forehead and eyebrows with frontal sinuses were sutured back, but was complete failure. Advice: Keep the pieces



Fig. 1 Thin razor graft on mold, for eye socket.

the patient. Thus the very young and very old are not suitable for large and complicated flaps. As the forehead skin provides the best type of replacement tissue for any part of the face other than the eyelids, it should be used more readily in the female, who can cover the secondary blemish with her hair, than in the male who can not do so. Further, the female must often be spared the additional scarring of a pectoral or arm flap when a belly flap is equally available. The male can tolerate a low neck or chest disfigurement with equanimity in order to have a facial blemish restored with healthy skin. The presence or absence of hair must also be taken into account as between the sexes. Both the local and general physical condition should be gauged, the local from the point of view of vitality and infection, and the general from all points of view, not for getting the psychological. Finally the financial status enters the problem, and a decision to carry out a presumably inferior method of repair may have to be taken in order to shorten the stay in hospital and the number of operative stages.

It cannot but be admitted that this decision as to method of treatment is one of the most troublous that can face either surgeon or physician. Should the ideal be attempted with a considerable risk? Should the next best be carried out with less risk? Or should an inferior result be aimed at



Fig. 2. Loss of whole thickness of skin over bridge of nose. Left, immediately after loss; right, after replacement of piece of skin which had been preserved and was sutured into the nose 10 hours after accident.

with hardly any risk? Not only should a careful balance sheet be prepared of the pros and cons of the particular problem, but the surgeon's own predilections and experience must also be taken into consideration. Frequently it is almost impossible to state beforehand that the inferior method will always produce the inferior result, or the more troublesome superior method a perfect result. It is therefore frequently necessary to tell the patient to try the less-likely-to-be-successful method leaving the possibly more complicated and brilliant repair as the last resort. By such a decision a surgeon will often deny both his patient and himself the satisfaction that each deserves. We therefore return to the cardinal principle of medicine and surgery, namely, that the patient, not the condition, must be treated. In this respect it should not be forgotten that the psychological outlook of the particular individual will modify the treatment plan.

However, in order to have a basis for arriving at one's decision, the accompanying tables of repair by free and pedicle grafts have been prepared. They are admittedly most incomplete, and savor of that dogmatism which should be absent from the reconstructive surgeon's mind: the guarded use of opportunism is an essential factor in plastic surgery.



Fig. 3 Traumatic loss of nose and lip. Up and down variety (Gillies) of forehead flap

TABLE II—PLAP3

[illegible]



Fig. 4. Electrical burn of nose, eyebrow and cheek. Variety of Gillies "up and down" flap with secondary use of pedicle to form eyebrow and cheek.

METHODS OF REPAIR

The cases may be divided into two groups. In Group 1 the repair is accomplished by the introduction of new tissue. In Group 2 by replacement of displaced tissue. In Group 1 free grafts and flaps are used in the repair. By an autologous or free graft is meant the transplantation of a completely detached portion of the body and its reapplication to another. In surface wounds when function and form are desirable the whole

of the contracting scar or granulating area should be excised prior to the application of the graft. Surface grafts may, however, be definitely applied to clean granulating areas by one or other of the methods. The functional and æsthetic results depend on so many factors that no purpose would be served by a detailed description of them. Of the various grafts mentioned in Tables I and II, all are uniformly successful except perhaps the whole thickness skin graft and the mucous mem-



Fig. 5. Industrial accident. Partial scalping. Repair by single pedicle flap. Note the secondary wound was successfully closed by suturing in the scarred epithelium which was removed to accommodate the hairy flap.



Fig 6 Result of early treatment of road accident. Acromipectoral tube pedicle rhinoplasty stiffened with cartilage graft. (From *Med Press & Circ* 1934, April 11)

brane graft nevertheless one must bear in mind that there is still a great deal of experimental work to be done in connection with all forms of grafting.

The Group 2 cases, in which the repair is accomplished by replacement of displaced tissues include defects (A) soft tissue injuries and (B) fractures and dislocations.

A, 1 *Uncomplicated scars* The repair of simple scars might hardly be included under "reconstruction surgery," but an occasion may always arise when even if the scars have healed well by first intention or after a primary suture, the result is displeasing and the possibilities of excision and re-suture have to be considered.

Three main points may be stressed. The final repair should not be undertaken before all inflammation has subsided. Lymphatic obstruction

should be lessened by skilled massage, and the vascularization of scars increased. The value of the pre-operative and postoperative X-ray or radium treatment, by a skilled therapist, of keloid scars should be borne in mind.

The primary scar or scars, may then be etched together with all the underlying scar tissue, dirt, and foreign bodies. In these operations as in all plastic work, tissue trauma caused by the use of heavy instruments, or the clumsy use of light ones should be avoided. Hemostasis is important, haematoma being a serious complication. There is no contra-indication to the use of fine catgut ligatures, but with superficial vessels direct crushing is satisfactory. After complete undermining, the skin edges may be brought into accurate apposition, and in clean straight incisions one fine subcuticular silk worm gut stitch threaded



Fig 7 Traumatic loss of skin of forearm. Very large direct flap applied to the forearm.



Fig. 8. Severe unilateral facial burn. Repair: (x) Thick razor graft for eyelids (s) right and left acromipectoral flaps. Intermediate host, right wrist.

on an eyeless needle may be used. These stitches have the advantage of not passing through the skin edges except at the end and commencement of the incision. In certain cases ordinary interrupted stitches on eyeless needles are indicated. These interrupted stitches may be left in from 2 to 4 days the subcuticular longer, and protection may be afforded by a light gauze dressing applied with even pressure by mastisol or elastoplast fixation. As regards the postoperative care, the patient can improve these scars by self massage with sterile paraffin (Fig. 10)

A. 2 *Complicated scars* One would include in this section irregular Y shaped U-shaped, and depressed scars. The same principles are involved in their repair as in that of uncomplicated scars. There is frequently cicatricial contraction affecting the surrounding structures, and when released a gap is left which must be replaced by a simple advancement or transposed flap. During the suture of these flaps, care must be taken to ensure that they have a sufficient blood supply, and when re-sutured they should be under tension as



Fig. 9. Factory accident. Complete avulsion of scalp forehead, eyebrows. Bilateral abdominal tube pedicle. Intermediate host, the wrist, double attachment. Transference to scalp.

nearly that of normal skin as possible. With regard to depressed scars, the insertion of a fat graft may be indicated (see tables, also Fig. 11)

In the difficult vertically inclined depressed scars of the cheek, if the skin and scars are under

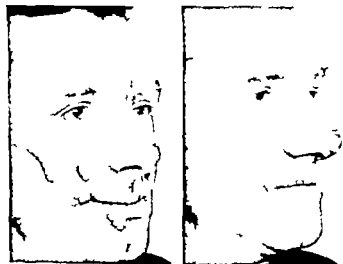


Fig. 10. Transport accident. Scarred and displaced soft tissues. Repair

HAND INFECTIONS IN INDUSTRIAL ACCIDENTS¹

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VARYING with the industry as shown by insurance statistics, hand infections still are responsible for from 5 to 9 per cent of all total disabilities. Were it not for these startling percentages I would not presume to discuss with this body of surgeons, whose primary interest has been the care of industrial accidents, some of the simple principles of surgery of the hand in relation to infections. Of the total hand disabilities 20 to 50 per cent arise from infections, a large proportion of these having their inception in trivial injuries. This number can be markedly reduced by a more widespread appreciation of the potential danger, a more intense campaign of education of the employee as to the importance of caring for simple injuries, of employers as to the economic value of prompt and efficient treatment, and of the profession as to the basic principles of diagnosis and treatment.

Certain etiological factors that should always be borne in mind have a peculiar application to industry. Employees as a rule live an indoor life, have little sunlight and often poor food. They are therefore debilitated and favorable subjects for the spread of infections. In cold climates we see this most often in the late fall or early spring, and in warm climates after the intense heat of the summer. During these periods the danger of virulent infections is increased especially in the freezing and melting period, due to the prevalence of influenza, tonsillitis, and similar infections with resultant streptococcal contamination of the blood stream.

Another factor is the ignorance on the part of employees that leads to primary inefficient or even harmful treatment such as neglect and fellow employees' treatment of simple injuries, as for instance the removal of splinters. It must also be admitted that too often the attending surgeon who would be vitally interested in a major injury, pays too little attention to these small injuries, especially in the follow up.

Again employees are peculiarly liable to trauma of the hands and to cracked calluses, both of which are fruitful sources of infections.

It has been found that certain types of infection are peculiar to certain industries. For example, confectioners, who handle fermenting fruits and spray them with sugar, and cooks and bartenders, who deal with fermenting grain and vegetables, are peculiarly liable to paronychia. In such cases

the nail loses its luster, turns dark, and is finally lost. A persistent chronic inflammation of the nail bed continues for weeks and months. If the cause is recognized and the occupation changed or if rubber gloves are worn the condition heals promptly. The surgeon caring for the patient has not done his duty until he has apprised the employer of the danger and taken steps to prevent the infection in other employees.

Office workers not infrequently accidentally break off pieces of indelible pencil which lodge in the skin. Ill advised attempts to remove the soft lead end in breaking it and fragments are left. The presence of these fragments results in local necrosis with chronic recurring local infection. In such cases the imbedded pencil parts should be removed by incision. If left until necrosis begins, the necrotic area including the fragments should be excised. We have had an exceptionally large number of severe infections in nurses due to inadvertent pricking of the finger with pins.

A type of infection not often recognized is that found among those who milk cows or tend cattle—the so called milker's nodule. The infection is caused by cattle hair entering a crack in the skin or being introduced at the time of an injury. Cattle hair has spines placed obliquely to the hair—somewhat like pineapple spines—and these hairs tend to work deeper into the tissue instead of being expelled as usually happens with foreign bodies. A local recurring infection that may last many months results and will not clear up until the hair is removed.

In the treatment of hand injuries, we have in our clinic come to rely on the meticulous application of certain procedures which we believe to be important—some of these are often neglected.

Severe injuries are treated promptly, hence infection does not often occur. If it does occur adequate drainage is provided. Any disability resulting is generally due to the primary injury or loss of tissue. The converse is true of the trivial injury.

In severe injuries we avoid primary antiseptic treatment, cleansing the wound only with soap and water unless grease is present, when some solvent is also used. We are also strongly in favor of debridement and primary closure of the wound if the treatment has been prompt. We also suture the tendons and nerves at this time if we do not fear infection. Where some hours have elapsed

or we fear infection we favor leaving the wound partly open for drainage, and do not suture tendons and nerves. If no infection ensues at the end of 48 hours we close such wounds and reopen after healing for the suture of the tendons and nerves.

Gas bacillus infections are the cause of too many fatalities due primarily to lack of careful observation and prompt treatment, and also to the fact that too much emphasis has been placed on the terminal picture of crepitation and evidence of gas spreading in the tissue. The time for the injection of gas bacillus antitoxin is either immediately as a prophylactic measure in those cases in which dirt contaminated with animal excreta is ground into the wound or in the incipient stages of the infection. If we wait until widespread crepitation is present or until gas can be demonstrated by X ray we have waited too long. The only way to avoid fatal delay is constant vigilance in any case not having an uneventful recovery. A sweetish peculiar odor may be present, but of more importance is the escape of two to a half dozen bubbles of gas as seen when the wound is dressed.

When we come to the question of treatment of the ordinary simple injury, the factors that have militated against prompt recovery are often found in the neglect of proper primary treatment. Such neglect may be due to the desire on the part of the patient to continue work, to the disinclination of the surgeon to place the patient on disability pay, to failure to realize that trivial injuries more often than lacerated wounds lead to loss of life and permanent disability, and finally to lack of knowledge or failure of application of the basic principles of treatment. Immediate treatment in the way of forcing out a drop of blood in punctured wounds, prompt removal of splinters and the application of an antiseptic such as iodine when immediate clean surgery is not available will do much to lessen the incidence of infections. Our essential line of defense must be the local and general resistance of the patient.

In both severe and trivial injuries a factor often lost sight of is that rest of the part by immobilization is of primary importance and in case there is any tendency of the infection to spread, the patient should be in bed. May I emphasize the importance of immobilization. It helps to prevent the spread of infection, aids in local healing and is too often neglected. We see too many ambulatory patients with simple non-immobilizing dressings favoring prolonged healing. Even injuries in the neighborhood of joints are often not immobilized. Again surgeons too often forget that if the infected hand is treated with the fingers extended,

ankylosis with permanent disability may ensue, even though the infection is controlled. I cannot emphasize too strongly that immobilization whether by simple splint or voluminous hot dressings should always be so applied as to place the hand in the position of function. A large percentage of the disability now seen following simple injuries could, we believe, have been avoided by adherence to this simple rule. Also we have seen nothing to change our opinion that in case of doubt or the demonstrated presence of infection voluminous hot moist dressing up to the shoulder is of great aid. Koch has recently drawn attention to the experimental work of Hudack and McMaster demonstrating the spread through the lymphatics of dyes within 30 seconds after injection. Without doubt bacteria spread from the site of the punctured wounds with almost the same rapidity. Therefore any incisions in non localized spreading infections, except in phlegmonous erysipelas or gas infections, will not only do no good but will be positively harmful.

Another simple truth, lack of knowledge of which has cost insurance companies much and entailed prolonged disability for the patient, is that where we see long continued suppuration in the hand there is in all probability necrosing tendon or devitalized bone requiring adequate surgical procedures.

There are many other factors that lack of time prevents me from considering. Among them may be mentioned the wide and not evident injury to tissue in the electrical burn, the lack of appreciation of the peculiar anatomy of the metacarpophalangeal joint and its relation to prolonged infection.

For the same reason I cannot discuss the peculiar anatomy of the hand, the sites of predilection for pus, the normal channels of extension or the general principles of diagnosis. Information as to these matters is available to those who desire it. However, I must emphasize that the most fruitful source of death and disability arises from the surgeon's failure to differentiate lymphangitis from suppurative tenosynovitis. The diagnosis is difficult but not impossible. The suffused redness, more general edema and often red lines of lymphatic infection in lymphangitis are sharply contrasted with the symmetrical enlargement of one finger, great in comparison with the associated edema of the others, tenderness sharply outlined by the anatomical outline of the tendon sheath most marked at the proximal end and pain most marked at the same point on extension of the finger. In suppurative tenosynovitis serve to differentiate the two.

Failure to differentiate them may lead to an ill advised incision in lymphangitis with not infrequent unnecessary complications and death or on the other hand delay in drainage of the tendon sheath may result in loss of the tendon and prolonged convalescence. Most of the deaths we have seen have been due to ill advised incisions in lymphangitis and the greatest proportion of severe disabilities have had their origin in suppurative tenosynovitis in which drainage had not been promptly instituted.

Finally may I discuss some of the broader aspects of the question. While adequate education of employees and employer has been established in many of our large industries, there is still much to be done. Every surgeon having responsibility for the care of any plant no matter how small should not consider his duty done when he has cared for the injured man. He should analyze his accident cases as to the causes and immediately take steps to prevent a recurrence.

He should establish such co-operation with plant managers as will permit his intimate knowledge of conditions about the plant that may favor injuries or infections.

The casualty companies check carefully as to elevator weakness, explosive mixtures, open machines, and similar evidences of gross negligence but too often no one checks the plant for the source of common simple injuries and I doubt if any one but the doctor can do this. Each plant is a problem in itself. Wire ends on boxes, exposed fragments of tin, splinters on buns, pins on packages and projecting nails cost the insurance companies a score of times more for disability expense than do elevator accidents.

In a certain plant Mock noticed that minor scratches with subsequent infection were often due to the lining of buns that had become splintered by use. The department manager was warned and in one year the injuries from this source were reduced 86 per cent.

Employees and foremen should be educated by lectures and posters of the dangers and have knowledge of the procedures immediately necessary in case of accident. Fellow employees help with splinters should be avoided and the employee taught to see the doctor or nurse, or failing these to apply iodine at once.

Employers and insurance companies should be educated as to the financial saving by prompt treatment and early hospitalization in case of doubt. This latter is of vital importance. Deaths and morbidity arising from infections following

simple injuries in a majority of cases occur in ambulatory cases. Mock reports that in 250 serious cases treated by ambulatory methods 83 per cent required incisions, and in 150 serious cases treated with prompt hospitalization only 53 per cent required incisions.

This emphasizes not alone that hospitalization is important but also that the surgeon should arrange for an adequate follow-up of his simple injuries so that he may know not tomorrow but immediately if infection is developing and be able to institute prompt and efficient treatment. Such close follow-up except in few instances, is now seldom instituted.

There are 4 parties interested in an industrial accident—the employee, the insurance company, the employer and the doctor. The employee's interest is in the patient himself and his compensation, the insurance company's in economic factors and the employer's and doctor's, in both. This quadrilateral interest has led to some confusion, misunderstanding and not infrequently to inadequate care. Each party has felt its interests might be jeopardized and has fought against imposition. I need not elaborate upon malingerers of the patient, the pressure of insurance companies to cut legitimate charges with its consequent temptation to padded service and fees, the difficulty of convincing insurance companies and employers that a larger primary expense for prompt hospitalization and efficient treatment is cheaper in the end, the inefficiency of service when the patient and the insurance company each feel their interests are opposed and act accordingly. The doctor cannot serve two masters when each demands a different service.

In reality however I am convinced that each party is willing to do his part. All wish efficient service and it is the doctor who by giving it can harmonize the divergent attitudes. I venture the assertion that if the industrial surgeon will give a more imaginative service, will assume the responsibilities I have mentioned, not alone treat his patient, but by adequate analysis find the frequent causes of such accidents in any given plant and take steps to prevent them, will institute personal plant investigation with recommendations as to how accidents may be prevented, and will foster educational programs designed to lessen the consequences if they occur, not alone will accidents and infections be lessened but many of the social and economic difficulties causing friction between the 4 groups interested will disappear.

OPHTHALMOLOGY AND OTOLARYNGOLOGY

VASCULAR CHANGES IN THE RETINA¹

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A SERIES of original photographs of the ocular fundus were presented and a demonstration was given of several variations from the normal in the blood supply of the retina. The fact that mere tortuosity of the retinal vessels is in itself not a sign of disease was emphasized. Diseases affecting the blood vessel walls can be promptly recognized by early changes in transparency. This was well portrayed in the pictures of cases with patches of sclerosis and in others of extensive atheroma. The sudden occlusion of the central retinal artery—so called embolism—was also illustrated and discussed, and the rapid

closure of the central retinal vein—so called thrombosis—was described with the aid of several slides. The demonstration of the circulation in and about the macula included arteriosclerotic changes in the retinal and also in the underlying choroidal vessels. Due emphasis was laid upon the impossibility of definitely diagnosing optic nerve lesions simply by the color of the disk. The value of stereoscopic fundus photographs was emphasized; they afford the most exact and earliest evidence of fundus changes including the optic nerve expression of intracranial disease.

SIMPLIFICATION OF PROCEDURE IN PLASTIC SURGERY ABOUT THE EYES¹

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THERE is a tendency for plastic surgeons to think complexly, plan complexly and operate elaborately. The simpler plastic procedures can be made, the better. Whenever it is possible detached grafts should be used for repair of the eyelids. Whenever possible skin of the upper lids should be used for grafting on the lower eyelid, or skin of one upper eyelid should be used for grafting on the other upper eyelid. Full thickness skin devoid of underlying tissue should be used. In case of severe ectropion, if the upper lids are involved, skin epithelium can be used for most cases, and epidermis without true skin taken from the lateral aspect of the thigh is the tissue of preference. For lining a newly constructed socket, skin epithelium (epidermis) without any true skin is best. If only epidermis is taken there will be no hairs and no glands, and so no secretion. The 'Thiersch graft' contains connective tissue and it is not appropriate for socket lining. Best results are obtained by exci-

sion of particles of old conjunctiva, which may give annoying secretion. If the socket is completely lined with epidermis, it will be clean, except for a little exfoliated epithelium, which is easily removed from the skin-lined socket.

There is no need for the surgeon to use pedunculated grafts in the reconstruction of an obliterated socket. Rarely, pedunculated grafts have to be used in reconstruction of the eyelids. For substitute eyelashes strips from the lower part of the brows can be transplanted. These do not have to be pedunculated. For obliterating false passages between skin surface and nasal cavity pedunculated flaps from the upper lid should be used. These should be lined with skin epithelium a few weeks before the pedunculated flaps are turned into place. The lining should accurately fit the opening and it should be free from hairs. For restoration of brows skin from the occipital scalp serves fairly well. Pedicles are not necessary.

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CLINICAL STUDIES IN SLIT LAMP OPHTHALMOSCOPY¹

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From The Wilmer Ophthalmological Institute of the Johns Hopkins University and Medical School

THE slit-lamp ophthalmoscope is an instrument which combines the highest attainable clarity in the ophthalmoscopic image with the possibility of oblique focal illumination of the posterior segment of the eyeball. The advantages of oblique focal illumination for the examination of transparent and translucent media have been well known in ophthalmology for a long time, and the application of this principle in the development of the corneal

microscope has been a great clinical and scientific advantage. It is to be hoped that similar advantages may result from the application of the same principle to the examination of the posterior segment of the eye.

Lantern slides were presented which showed the appearance of the posterior portion of the vitreous, hyaloid membrane, retina, optic disc, and choroid in normal and various abnormal states.

INTRAVENOUS TREATMENT OF DISEASES OF THE UVEAL TRACT²

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IT would appear from the clinical data so far assembled that the optimal time for commencement of treatment by gold salts in cases of iritis, indocyclitis, and scleritis is after subsidence of acute inflammation in the anterior segment of the globe. Before that stage we believe that other more effective remedies can be used. In any event, every means at our disposal for improvement of the patient's general health is employed.

Patients who improved under tuberculin therapy were not given gold salts. The selection of patients for intravenous administration of gold included many in whom clinical or biological evidence of active tuberculosis could not be demonstrated. Gold sodium thiosulphate is given intravenously in courses of approximately 20 injections. It is our practice to start with 10 milligrams and increase the amount slowly until the patient is receiving 50 milligrams twice a week, as the maximal dose. If

the patient shows the slightest sign of intolerance, use of the drug should be discontinued temporarily, and when its use is resumed the dose should be half of that which produced the reaction. We have found it advisable to prescribe a rest of 2 months following a course of 20 injections; a similar series of injections may then be repeated if the response has been inadequate.

The drug is poorly tolerated by the markedly debilitated patient, by one with advanced, active, febrile, pulmonary tuberculosis, and by patients with advanced hepatic or renal disease. For pregnant women the dose of the drug should be smaller by half than that ordinarily given. A reaction may appear immediately or be noted a considerable time after injection. Treatment thereafter should be cautious or should cease. Using this method of treatment in ophthalmological cases we have had no complications.

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¹Because of lack of space, considerable important material has been omitted from this abstract. This material will be included in the author's reprints. Paper presented before Section on Ophthalmology, Clinical Congress of the American College of Surgeons, Boston, October 19, 1934.

THE CLOSURE OF THE CATARACT INCISION¹

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It is a well recognized surgical principle that, unless drainage is indicated, operative wounds should be sutured and not left for nature unaided to make the closure. Rapid healing is thus obtained, infection is avoided and the danger of postoperative hernia is reduced to a minimum. Incisions into the cranial cavity, abdomen, or thorax, are sutured. Why should an incision in the eye remain unsutured?

After the ordinary cataract section the edges of the wound tend to adhere. We all know however from past experience that such a closure is not free from complications such as delayed union, reopening of the wound by coughing and straining, downward growth of epithelium into the anterior chamber (Elschnig has demonstrated this) prolapse of iris, vitreous loss, expulsive hemorrhage and late infection.

The use of a suture after the cataract operation was suggested by Williams of Boston in 1867. Since then many modifications have been described, especially by Kalt in 1894 and Van Lint in 1911. The extraction of the lens beneath a bridge of conjunctiva was, according to Schweigger, suggested and used by Desmarres in 1851 and published in 1858.

Husain, in 1918 described a conjunctival flap method in which an opening in the anterior chamber was made with a keratome and the angles were enlarged with scissors. Holbrook Lowell of Boston reported, in 1920 a series of operations done after this method. A modification of this sutured pocket flap has given me the least number of operative and postoperative accidents. As the method has been described elsewhere (3) only a brief account is here given.

A horizontal incision, 15 to 20 millimeters long and 5 to 8 millimeters above the limbus, is made in the conjunctiva. This is dissected to the lumbus and down on each side with blunt scissors to nearly a level of a horizontal line, thus forming a deep pocket. A mattress suture of fine silk on a round needle is placed in the conjunctival edges and the loops of the suture are placed on each side so as to be out of the field of operation. A suture is placed in the superior rectus as suggested by Angulucci. Holding the flap of conjunctiva with blunt tissue forceps, thus securing a 2 point fixation, an incision is made at the lumbus and beneath the conjunctiva with a narrow Graef knife. If the incision is too far back, an iridectomy results if too far forward, a buttonhole is made in the conjunctiva. These accidents are to be avoided but an iridectomy is not objectionable and a buttonhole changes the operation to that generally done when no conjunctival flap is made. The anterior capsule is removed with tooth forceps. By holding the flap of conjunctiva forward, the

edges of the wound are separated and the lens is expressed with a spatula. If cortex or blood remain, the anterior chamber is irrigated. The suture is tied and the wound is secure.

The lens may be extracted, in this type of incision with forceps, by tumbling by traction by vacuum, or after a capsulotomy. The simple or combined extraction may be used and irrigation may be employed if indicated. During the delivery of the lens the traction on the conjunctival flap not only fixes the globe but also enlarges the wound and thus aids in the exit of the lens. There is less danger of vitreous prolapse than in the usual method when the two spoons are used the one to express the lens and the other to make a backward pressure on the scleral portion of the wound. In case vitreous

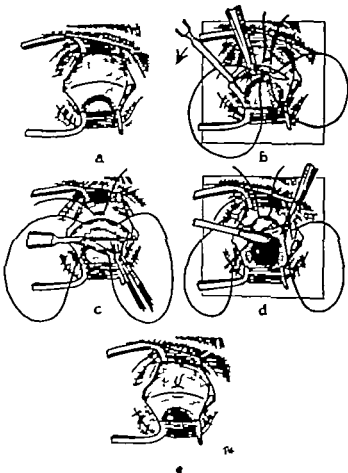


Fig. 1. Cataract extraction pocket-flap method. a, The incision in conjunctiva b, conjunctiva pocket made mattress suture in place, flap held up to secure fixation, knife beneath the conjunctiva for the puncture; c, counter puncture made, flap held down to secure visibility and to fix the globe; d, the incision completed at the limbus, the lens is expressed; e, wound is closed.

presents, the eye can be immediately closed without loss of contents, just as when loops of intestine present in an abdominal section. The opening in the globe is made in a clean field and thus the possibility of infection is reduced to a minimum.

This operation differs from other methods of suturing, as suggested by Williams (1867), Kalt (1894), Czermak (1903), Van Lint (1911) and other writers, in that there are no open angles to the wound and should prolapse of iris occur the latter is protected by the layer of conjunctiva. There is no danger of late separation of wound edges as the sutured flap is as firm in hours as the unsutured wound is in days. Delayed healing is thus avoided. The down-growth of epithelium into the incision and anterior chamber is not a possible complication since no epithelial margins are exposed, the incision being beneath the conjunctiva. The astigmatism is less after an incision of this kind than when the opening is made at the limbus or in the cornea. Convalescence is rapid and safe; most patients are out of bed the day after operation. The danger of late infection is reduced to a minimum.

The only objections to this operation are that there is lack of visibility; the operation is longer; the suture requires removal, and there is slightly more bleeding. The lack of visibility is more fancied than real. Three minutes increase in the time of operation saves days in bed and reduces the time of hospitalization by one-half. The removal of suture is necessary after any operation and needs little consideration. Bleeding into the anterior chamber is objectionable but not serious, as the hyphema is quickly absorbed.

BIBLIOGRAPHY

1. HERRICK, T. Another new operation for cataract. *Indian M. Gaz.*, Calcutta, 1918, 53: 12-17.
2. SCHWENKGER, C. Simple extraction downward. *Arch. Ophth.*, 1898, 27: 255 and 256.
3. SPRATT, C. V. (a) Pocket flap in cataract extraction. *Am. J. Ophth.*, 1928, 21: 347. (b) Pocket flap. *Tr. Sect. Ophth., Am. M. Ass.*, 1931, p. 96.
4. WILLIAMS, H. W. (a) Cataract extraction operations. *Roy. Lond. Ophth. Hosp. Rep.*, 1867, 60: Pt. 1. (b) Cataract extraction. *Arch. Ophth.*, 1869, 1: 101.

with these one must possess a knowledge of broncho-pulmonary and oesophageal diseases, together with a general appreciation of chest diseases, in addition to experience with laryngological problems.

The untrained endoscopist who does an occasional bronchoscopy or oesophagoscopy has few successes to report; he subjects his patients to unjustifiable hazards. In no field of medicine do end-results bear such a definite relationship to training, skill, team work, and other factors. In foreign-body work the end-results are positive. Either the foreign body is or is not removed; but injury to the patient may convert an apparent success into a failure.

To the uninitiated certain foreign-body cases, notably coins or safety-pins in the cervical oesophagus, appear to be easy. Nothing could be more misleading. All foreign-body cases should be considered difficult since a certain degree of special training and skill are necessary for successful removal. The difficulty in removal seems to increase as the skill of the endoscopist decreases. Unfortunately the unskilled are often called in to handle emergency cases. These cases generally call for the highest degree of judgment and skill and should be undertaken only by one who is competent. It is far safer to do a diagnostic bronchoscopy in a case of suspected bronchiectasis than to attempt to remove a difficult foreign body from either air or food passages.

Any physician contemplating the practice of peroral endoscopy should prepare himself by special training under competent guidance until he has mastered the

ordinary technical difficulties. This should ultimately include a course of training on the living patient. In addition, he should be familiar with the practical clinical aspects of the subject. While much of this can be gained from medical literature, one's fundamental training should be supplemented with actual clinical experience. The matter of equipment is a common stumbling block. A careful selection of instruments is highly important, and one cannot economize on the essentials. Diameters of tubes and lengths of forceps must vary as do the anatomical measurements of air and food passages in infants, children, and adults. To attempt to pass an adult bronchoscope in a child bespeaks absolute ignorance of the fundamental principles of bronchoscopy. One should use tubes suited to the patient and the problem under consideration. This applies to all other instruments. The use of suitable equipment is fundamental in peroral endoscopy and is the only way to practice economy in saving human lives.

To summarize, peroral endoscopy in its broadest application is a field for the otolaryngologist. The scope of the work is as diversified as the diseases of the tracheobronchial tree and oesophagus are. A knowledge of the general medical aspects of these organs should be considered necessary. One engaging in peroral endoscopy should be thoroughly trained in the technical phases as well as the clinical application of the subject. An adequate physical equipment is indispensable.

THE RECOGNITION AND TREATMENT OF ONE TYPE OF MÉNIÈRE'S DISEASE¹

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THE term Ménière's disease as used in this paper does not imply a hemorrhage into the inner ear but is descriptive of the symptoms. This paper describes the otological findings in 40 patients with Ménière's disease. The symptoms in each of these patients were (1) tinnitus—usually limited to one ear (2) impaired hearing—usually limited to one ear and (3) violent and sudden attacks of vertigo.

In 37 patients in this group the entire auditory nerve (cochlear and vestibular) was divided intracranially by Dr. Walter Dandy. In the 3 remaining patients only the vestibular nerve was divided. The intracranial division of the vestibular nerve without damage to the auditory or facial nerves has been successfully carried out on 10 additional patients since this paper was written. In every case the division of the vestibular nerve promptly stops the attacks of vertigo.

The etiology of the disease is unknown, but there are many factors which suggest that the lesion is not located in the cochlea but either in the nerves or the more central auditory and vestibular tracts. At any rate the division of the vestibular nerve, which severs the connection between the end-organs in the

semicircular canals and the central connections, will always stop the attacks of vertigo just as the division of the sensory root of the fifth nerve will stop attacks of trigeminal neuralgia.

The characteristic hearing defect in these patients with Ménière's disease is of the inner ear or nerve type. Air conduction is better than bone conduction and bone conduction is shortened or nil. In no case with attacks of vertigo was the deafness complete.

The semicircular canals on the affected side when tested with the caloric test are sometimes hyperactive, sometimes the response is normal and sometimes it is very subnormal or entirely absent. In our experience the results of vestibular tests are of little value in the diagnosis of this disease.

It is characteristic of Ménière's disease that there are remissions, or long intervals of several months or even years during which the patient is entirely free from the attacks of vertigo.

Intracranial division of the vestibular nerve on one side, or on both sides if necessary, is the treatment of choice, and in the last 13 cases this operation stopped the attacks of vertigo without further impairment of hearing.

¹Abstract of paper presented before the Section on Otolaryngology, Clinical Congress of American College of Surgeons, Boston, October 17, 1934.

THE DIAGNOSIS OF CHRONIC INFECTION OF THE TONSILS IN RELATION TO INDICATIONS FOR OPERATION IN CASES OF CHRONIC FOCAL INFECTION¹

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INTEREST in this subject has been revived by a number of symposia, held in England by the Fellowship of Medicine recently under the conduction of Tilley Glover McKenzie, and in this country by I. W. Dean at the 1934 meeting of the American Medical Association, by Kaiser Nissen and Mosher at the American Academy meeting and by the writer and William Gordon in the spring of 1934, before the Philadelphia County Medical Society.

Adverse criticism has been levelled at the profession because of the practice of indiscriminate removal of the tonsils.

To settle these questions, it is necessary to study carefully the clinical anatomy, the physiology and the histopathology of the tonsils, and correlate these with organic disease produced elsewhere. It is also necessary to define clearly what constitutes a diagnosis of tonsillar infection. It is generally accepted that the tonsils may act as a portal of infection for other parts of the body as well as constitute a primary cause for infectious processes of focal origin elsewhere in the body but it must not be forgotten that the infected tonsils may be only one of several such agents. Pemberton has shown that 50 per cent of a group of arthritics recovered or improved even in the presence of such a focus.

Often, removal of infected tonsils fails to give relief because other foci of infection that are present are overlooked. Thus foci may exist in the teeth, sinuses, ears, gall bladder, gastro-intestinal tract, prostate, etc. Often individuals may carry septic tonsils for years and show no evidence of disease processes elsewhere from this focus of infection because the resistive powers of the individual are great enough to counteract the toxins fed into the system from the tonsil infection. Any lowering of the resistance or increased virulence of the infection may upset this balance so that symptoms due to focal infection may manifest themselves.

Clinically the following points may be accepted as proper criteria for the diagnosis of septic tonsils, though some authorities may lay more stress on different individual points: the history of local tonsillar inflammation, acute or chronic. Hajek's dictum—repeated attacks of acute tonsillitis; one or more attacks of quinsy; repeated coryzas beginning with sore throats, soreness or discomfort in the tonsillar region; cervical adenitis (dental sepsis eliminated); enlargement or tenderness of the tonsil node at the angle of the jaw; gross hypertrophy of the tonsil, the anterior pillar having an inflamed, reddish or purplish hue, especially at the upper part. Liquid pus expressed from one or more crypts by

drawing the anterior pillar forward and outward and pushing behind the tonsil. Pus may be often found in the crypt of the upper pole. Aspiration may be useful. A tonsil that is firmly attached to its fossa suggests a previous quinsy; many attacks of acute infection, or a long process of chronic infection. Simple tonsillar hypertrophy with enlargement of the cryptal orifices often shows eventually small ulcero-congestive lesions at their borders. Bacteriological examination if a streptococcus is recoverable, is accepted by some as strong confirmation of other signs and symptoms. Caseous masses should place a tonsil under suspicion. At times these masses are accompanied by liquid pus. The masses themselves do not warrant tonsillectomy except for social reasons such as bad breath. Small purulent collections concealed in the crypts by inflammatory adhesions, often plainly seen, are diagnostic.

We cannot with any assurance say that a given tonsil is not infected unless it is proved so by bacteriological and pathological investigation after removal. How often do we see pus gushing from the crypts after applying the snare or guillotine to a fairly innocuous appearing tonsil?

Having made the diagnosis that a given tonsil is infected, we must decide whether it is actually causing damage or is likely to cause it in the future.

Regarding prophylaxis, opinions vary. Kaber states that prophylactic tonsillectomy did not make for great immunity to recurrent infections of the respiratory tract, to contagious disease or rheumatism. Horace Williams in the Philadelphia Hospital for Contagious Diseases showed conclusively that the children who had middle ear suppuration and complications almost without exception had not been tonsillectomized.

McKenzie doubts the value of statistics used to disprove the value of tonsillectomy. He asks whether the tonsils were completely removed, whether, in some cases, only adenoids were removed, or whether there were regrowths or recurrence of the lymphoid tissue.

Herbert Tilley states that a septic tonsil should be removed, but deprecates the wholesale removal of tonsils without a careful study of the case.

Tonsillar sepsis in relation to focal infection and distant pathological conditions requires the co-operative study and observation of the otolaryngologist and the attending physician. A connection between the infected tonsils and the distant disturbance should be proved if possible. The study should be extended to all parts of the body as insisted upon by Nissen. Close clinical observation over a considerable period of time by the physician

plus frequent reports of subjective symptoms by the patient are essential to determine the association between the local and systemic infection.

The diagnosis of tonsillar infection rests with the otolaryngologist, but the most careful and meticu-

lous study of the case as regards the relationships between the local and systemic infection will depend on co-operation on the part of the otolaryngologist with the attending pediatrician, internist or surgeon.

THE PRESENT STATUS OF INFECTION OF THE UPPER RESPIRATORY TRACT IN RELATION TO FOCAL INFECTION¹

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IN the evaluation of the importance of focal infection in various systemic diseases, careful study and rational judgment should replace illogical jumping at conclusions. Because a focus of infection is discovered does not mean that it is causing the patient's symptoms or that its removal will cure him. This may be coincidental.

The relative importance of the various foci of infection are as follows: teeth, tonsils, prostate, cervix, gastro-intestinal tract and sinuses. Absorption from teeth is more likely than from other foci because of their anatomical structure and the fact that the infection is well locked in. Tonsils are likely to be an important focus of infection and their removal is indicated often for prophylaxis even when no causal relationship can be demonstrated between the disease and the tonsillar infection. Sinuses are less likely to be a factor in focal infections, and their importance has been greatly overrated by some specialists. If there is infection of the sinuses, conservative treatment should always be used before operations, which perhaps are unnecessary are resorted to.

Among the diseases in which focal infection has been emphasized as a causative factor are infectious arthritis, rheumatic fever, chorea, valvular heart lesions, nephroses and nephritis, and hypertension. In my experience the removal of foci for nephroses

or hypertension is usually disappointing, but may be indicated in some cases for improving the general condition.

The removal of foci has not effected any improvement in hearing in cases of eighth nerve deafness, in my experience. Quite often, numerous fruitless operations are performed before the correct diagnosis of fifth nerve neuralgia is made.

Toxic labyrinthitis is one condition that has been definitely benefited by the removal of foci, and there are definite indications for tonsillar operations in eye conditions, such as iritis and inflammation of the uveal tract. In my opinion papilledema and neuritis of the optic nerve are not due to infection in the sinuses.

The warning is reiterated that operations for the removal of foci should be performed only after careful study of the patient and the correlation of all factors which are contributing to his illness. The fallacy that tonsillectomy is a panacea for all ills should be combated vigorously. That this warning is necessary is indicated by the numerous cases of congenital and advanced deafness I have seen in children on whom one or more operations have been done without benefit and yet no attention has been given to the things that might really help the patient, such as instruction in lip reading, hearing aids, etc.

THE CELLULAR CHARACTER OF ONE HUNDRED TEMPORAL BONES CLINICAL AND SURGICAL SIGNIFICANCE¹

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THE embryological development, histological character and anatomical configuration of the temporal bone is of prime importance for a clear conception of its cellular system, the pathological changes it may undergo and proper therapeutic application. It is a composite structure composed of a squamosal and a petrosal portion, the former a flat bone, the latter a long bone. This gives it an individualism of its own. Within compact osseous walls is primarily diploetic tissue, which may be modified by age, biological factors, systemic disease or early infection in the middle ear cavity. Though the temporal bone contains the otic capsule with other important structures, the change that it may be subject to is one of bone pathology, and its surgical therapy should be based upon this principle, modified and altered to meet the special anatomy of that portion of the structure involved.

The apex is similar to the epiphysis of other long bones, and subject to the same pathology that may occur in similar structures. It may be invaded from the middle ear or mastoid antrum by continuity of tissue or by vascular transmission, also from pathological conditions extraneous to the temporal bone. It is one of a localized purulent lesion, or one of osteomyelitis. Clinical evidence of abducens paralysis, facial or retrobulbar pain in the presence of middle ear or mastoid disease is indicative of petrosal tip pathology. The rationale of the proper surgical treatment depends upon a knowledge of such pathology.

The following is a summary of the gross observations relative to the cellular character and anatomical location of one hundred temporal bones sectioned in various planes. The terms anterior inferior and posterior are used in relation to the three surfaces of the pyramid. The mixed type is placed under the caption that represents the predominant type of cell present. From these observations referable to the surgical anatomy with its clinical and surgical application, the following conclusions are presented:

1. From the observations presented, the cellular character of a majority of temporal bones is the mixed type.

2. The petrosal tip however is predominantly diploetic.

3. The diplo-pneumatic cell type was found to be the most prevalent in the mixed cell type.

4. The cellular character of the mastoid is not a true index to other portions of the temporal bone.

5. The surgical anatomy as presented leads to the inference that the most prevalent route of invasion

to the petrosal tip is from the mastoid by way of the posterior aspect of the pyramid, then by way of the anterior surface from the zygoma, or the peritubal or carotid canal directly from the middle ear and finally by way of the retro-facial area via the bulb cells.

6. Petrosal tip pathology may occur by way of continuity of tissue or by vascular extension from infections in the middle ear or mastoid, also from pathology extraneous to the temporal bone.

7. The peritubal cells serve as a route of evacuation rather than one of invasion to the tip.

8. The logical approach for drainage to localized purulent pathological conditions in the tip is by way of the peritubal cells, and for osteomyelitis a subdural approach either from the mastoid or directly by way of the middle fossa.

9. The variance in the surgical anatomy of the temporal bone impresses one with the fact that clinical evidence, based upon the pathology present, should be the guide to type of therapy used.

SUMMARY OF FINDINGS OF 100 SPECIMENS

No. temporal bones	Anatomical location	Cellular character		
		Diploetic	Pneumatic	Mixed
Mastoid	Mastoid	9	15	5
	Mixed	—	5	5
	Total	—	20	10
Zygoma	Zygoma	14	—	7
	Mixed	—	10	13
	Total	14	10	20
Pyramid	Anterior	—	17	5
	Mixed	5	19	5
	Total	5	36	10
Inferior	Inferior	14	14	5
	Mixed	—	—	—
	Total	14	14	5
Posterior	Posterior	18	10	6
	Mixed	7	11	6
	Total	25	21	12
Tip	Tip	15	6	—
	Mixed	—	6	—
	Total	15	12	—
Bulb cells	Bulb cells	13	14	13
	Mixed	10	14	7
	Total	23	28	20

RECENT DEVELOPMENTS IN THE DIAGNOSIS OF MENINGITIS¹

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BEFORE one enters into a discussion of the recent developments in the diagnosis of meningitis, it is necessary to clarify some misunderstandings concerning old concepts. There are many problems concerned in otogenic meningitis. It has been customary to limit our view to the finding of a specific invading organism in the cerebrospinal fluid, to the clinical manifestations which the tissue reactions produce in the form of symptomatology and to autopsy findings.

The desirability of very early diagnosis has been stressed and yet the evolution of the meningeal lesion has not been accorded its grave significance in the earlier stages of its development. The fact has been overlooked that the evolution of the meningeal lesion may be halted before data which are usually accepted as of diagnostic import are available. Finally we have performed anatomical channels of the middle and the inner ear spaces and have accepted them as the obvious tracts along which an infection must travel on its way to the meninges without in many cases having established beyond any reasonable doubt that the endocranial invasion was spread by these routes and we have accepted recorded cases as otogenic without histopathological proof of such invasion. On the other hand, the general principle of infection by retrograde thrombosis and by metastases along blood channels has escaped our serious consideration.

Nor have we studied the cases which have recovered from meningitis in sufficient detail and accorded them the notation which the data they present merits. We have not a general knowledge of those aspects of the clinical picture which drop out in the records of our recoveries. We have been too prone to question the diagnosis in recovered cases. Nor have we always accepted a diagnosis of meningitis unless it gave undoubted evidence of bacterial content in the spinal fluid. We believed that the lesion was of different nature with the differing bacterial content and while it is true that we studied cytology we held that the finding of one class of cells as against another type of cell content in the fluid indicated a different meningeal lesion. We were wont to consider the lesion as an inflammation of the meninges due to a bacterial invader and we left out of account what happened to the brain substance itself and the rôle that this played in the evolution of the clinical picture. We have studied the cerebrospinal fluid and it was held that it was infected, as indeed it was, but we failed to comprehend that much that was found in the fluid was really the washed off products of disease located in the brain tissue and in the blood channels.

Hence, the progress which has marked most of the otological research has been inadequate in this field

of work. Very little progress has been made and today meningitis is still the unsolved problem in our field of medicine.

Before advance can be made it will be necessary to restate fundamentals and postulate upon these a newer conception of this lesion and with this in view I present the following for consideration.

A. The meningeal inflammation including the inflammatory reactions of the brain tissue is the result of bacterial infection which most often reaches the affected parts by the route of the blood stream, traveling either directly by way of the perivascular spaces or, because of a spread endocranially, by a regression thrombosis from the veins of the mastoid process, the petrosal pyramid or the perivascular channels in the labyrinth which latter structures must have been involved in the infection beforehand.

B. Preformed anatomical structures may also be the tract used by an invasion to reach the meninges but in each case, before such shall be accepted as the route involved, histopathological proof must be acquired.

C. Meningitis is a generic term which has the sanction of usage. It is to be understood as describing a lesion which exhibits inflammatory reactions to bacterial invasions involving the meninges, the brain substance and the choroid plexus.

D. Cases of otogenic meningitis differ in patients of differing ages. A perusal of the literature shows that the lesion is more apt to resolve among the young than when it occurs among older individuals. There are more recorded recoveries among children than among adults, and in these the meningitis is apt to develop without the intervention of a purulent mastoiditis.

E. Clinical evidence stresses the fact that the symptomatology is grossly divisible into two groups of symptoms (1) those due to increased intracranial pressure and (2) those due to toxicity including the terminal sepsis from bacterial activity. If the predominating symptoms are those of pressure, this must be relieved early, but cure will not result until the other factors listed are also mastered. Time is gained, however, if the pressure element is relieved, to carry on measures to combat the other factors.

F. The establishment of surgical drainage does not answer the problem presented by meningitis because the lesion is a multiple one consisting of many small foci of active infection spread along the routes of many pial vessels. The problem is concerned with keeping the brain tissue alive. To accomplish this the results of brain tissue cell activity must be removed from the region about the brain cells and the desired means of doing this is

found in keeping the cerebrospinal fluid circulating. Any procedure which stops the circulation of the cerebrospinal fluid defeats the objective which is in view.

G Meningitis, as it is clinically seen, presents itself in stages. Diagnostic data will vary according to the stage at which we first recognize the disease. Each of these stages is in itself somewhat of an entity which changes as the lesion evolves and the clinical picture and laboratory data vary as these changes occur.

H Finally we should recognize that meningitis of otitic origin is as often a complication of acute purulent otitis media as it is the sequel of mastoiditis. We should differentiate those cases occurring during the course of an acute otitic infection from those following an acute mastoiditis. The time intervening between the mastoidal involvement and the first meningeal sign seems to have significance and the record of cases shows that the very poorest results are found in those in which mastoidectomy was necessary during the first week of middle ear infection. The cases which occur as sequelae of middle ear chronicities are again to be comprehended as of different origin. Often they are the result of secondary infections of cholesteatoma or the result of spreads endocranially of unrelieved, often unrecognized, labyrinthine perilabyrinthitis or petrosal pyramid infections. It becomes necessary to differentiate primary meningeal invasions from those which follow infections which are secondary to otitic invasion.

I The healed cases which are recorded in the literature give evidence that cures are obtainable in cases where the clinical picture is not stormy and the symptom complex can best be characterized as weak, and where pressure signs predominate over the signs of toxicity—the Babinski is often absent or only very weakly present and signs of pyramidal tract involvement are not distinctly marked.

The findings in the cerebrospinal fluid give the best indicator of the type of lesion present. The fluid shows the state of being of the brain tissue cells. It is a means of knowing and estimating the amount of intracranial pressure and through the study of its chemistry a knowledge is won of the tissue reactions, the intensity of their activity and the type of bacterial invasion which the given case presents.

Its physical characteristics are deceptive. Clear fluid has been known to show bacterial content and a markedly turbid fluid has been shown to be bacteria free. In view of the importance of the findings obtained from the examination of cerebrospinal fluid, it is necessary to stress the fact that the fluid must be examined immediately after it is withdrawn. The same fluid examined again and again after intervening hours will give different findings.

This holds true for cytology as well as for the chemistry of the fluid. The anti-bacterial properties inherent to cerebrospinal fluid must be remembered and even the search for bacterial contents must be undertaken immediately after the fluid is obtained.

After an interval of time, particularly in the early stages of the lesion, the fluid may be found sterile, whereas, had the examination been made at once, after lumbar puncture, it might have shown bacteria present.

According to most investigators the cerebrospinal fluid is a dialysate. It filtrates from the capillaries of the choroid plexus and from the capillaries of the perineural and penvascular spaces of the central nervous system. Eventually it reaches the venous blood channels, being absorbed into the lateral and longitudinal sinuses of the skull. In the normal state the fluid is in osmotic equilibrium with the blood plasma, and its production and flow may be said to be influenced toward an exaggerated production or a retardation by the relative dilution or concentration of the blood.

Cerebrospinal fluid carries on a dual function. It is concerned with the metabolism of brain cells carrying away the effects of metabolism and its other function is that of equalizing and maintaining intracranial pressure. Meningeal infection disturbs these normal functions. When the fluid cannot carry away the effects of metabolism, when it stands in its circulation results, the cells are poisoned by the products of their own activity and there develop those clinical signs of toxicity and neural reactions which are noted in the clinical picture.

The index of this toxicity can be estimated by studying the choline content of the fluid. Ordinarily the fluid transudes through the capillaries of the choroid plexus in the face of intracranial pressure, and this same pressure influences its absorption. The first effect of a bacterial invasion of the meninges is a great outpouring of fluid from capillary vessels. This is to be comprehended as a defense mechanism—an effort on the part of the body to cleanse itself of the invading pathogenic bacteria and the resultant tissue reactions. Clinically at this stage there is a demonstrable increase in intracranial spinal fluid pressure. To a great extent, the interconnecting orifices between the various ventricles and the meshes of the pia are still open and a real exudate has not yet formed.

The general effect of this increased intracranial pressure is compression of the blood vessels. Both afferent and efferent vessels are involved and there results a lessened oxygenation of the parts and the formation of large quantities of lactic acid follows.

Lactic acid is also present in increased amounts in the blood plasma, especially during fevers. Since the early stage of meningitis with which we are here dealing is always accompanied by fever it becomes necessary to estimate the amount of lactic acid present in the patient's blood plasma at the same time that the spinal fluid estimation is made. Lactic acid has been found to be very much higher in the cerebrospinal fluid than it is in the blood plasma and it is possible to establish a ratio between the two findings. The lactic acid content of the meningeal spinal fluid is apt to be four times that of the lactic acid content of the blood plasma.

There are several interesting and pertinent phenomena that result from the presence of this acid in increased amounts in the cerebrospinal fluid. These results can be comprehended as tissue reactions in the brain tissue cells and in a further chemical interaction in the chemical elements comprising the spinal fluid.

The second stage in the development of the meningitic lesion deals with intrinsic cell changes in the brain tissue, the cells of the choroid plexus, the perineural and perivascular spaces. Cell function becomes hindered, and as a result the effects of cell metabolism are found in the fluid in the forms of choline in greater amounts than normally. I assume that the detail of the lesion, at the stage in question is an edema of the structures concerned. My assumption is based on the known fact that the presence of the lactic acid in increased amounts must result in a changed iso-electric reaction of the spinal fluids and the cells bathed by it. Attention may here be called to the theory of Fisher, who places, in his studies of edema, its causative factor in the water binding property of tissue colloids. When small amounts of acids are added to iso-electric gelatin, its swelling power is enhanced. Fisher contends that the cause of edema is to be found in the accumulation of acid products in the tissues. I realize that Fisher's theory has been critically questioned and is held as not proved nevertheless, as far as the stage of meningitis is concerned with which I am dealing here, his theory seems to find a degree of substantiation. We have brain tissue colloids bathed in a fluid whose reactions are tending to swing toward the direction of 'lessened alkalinity' and as a result we see edema and an interference with cell function.

The presence of the strong lactic acid results in a decrease in the alkaline reserve, or since in the modern nomenclature the actual expression of acidity is termed in common usage the minus logarithm of

the actual concentration of the hydrogen ion which is present, we find a lowered hydrogen-ion concentration. Our finding in meningitic fluids is 6.9 and 7.0 instead of the normal 7.5. When it is remembered that a change of 1 in hydrogen ion is equivalent to ten times that amount in actual change in concentration of hydrogen-ion and that a lowering of the hydrogen-ion of 0.5 in blood cannot sustain life, the actual significance and fundamental character of the lowering of the hydrogen-ion of even 0.5 becomes apparent. The chemical phenomena of increased lactic acid in the spinal fluid has further consequences. The lactic acid being a strong acid drives off carbon dioxide from the carbonates hence in meningitis we should expect to find—and there is in fact found—in addition to the very considerably lowered hydrogen-ion a decreased bicarbonate content.

Summarizing the recent developments in the early diagnosis of meningitis are to be found in the differentiation of the cases. In the recognition that a positive bacterial content is not necessary to a diagnosis of meningitis in the early examination of the fluid after it is withdrawn this examination to include, beside the cytology and the bacterial examination, a chemical examination of the fluid which should show the choline content and the presence or absence of the copper reducing substance¹ the lactic acid in relation to its presence in the blood plasma, the sodium chloride the carbon dioxide and the determination of the hydrogen-ion, all in relation to the same elements in the blood plasma. When we have become habituated to the use of these laboratory aids, we shall have made a distinct step in the early diagnosis of meningeal infections.

In previous papers I called attention to the copper reducing element present in normal spinal fluid and to the significance of its gradual disappearance from the fluid as the meningitic lesion develops and bacteria become evident in the circulating fluid. Its reappearance in the examinations made later as of good prognostic significance.

MENINGITIS—THE RESULT OF DISEASE OF THE PETROUS APEX AND SPHENOIDAL BASIS¹

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THE theory of the specificity of function of a tissue, depending upon the embryonic anlage from which its cells evolve, is of surgical value in an understanding of pyogenic lesions of the skull as it furnishes an explanation for the variations in tissue reactions to infection of bones of unlike embryonic origin. Thus a pyogenic inflammation of a petrous apex or the sphenoidal basis (a) runs a distinctive course and (b) requires a different surgical viewpoint than infections of an adjacent cranial bone, such as mastoiditis, nasal sinusitis, or osteomyelitis of the cranial vault.

Petro-apicitis is frequently an unrecognized cause of meningitis. In the vast majority of cases, it is a true osteomyelitis. Petro-apicitis represents a different pathological and surgical entity from the recognized forms of mastoiditis, with which apical suppuration is usually but not invariably associated, occurring as it does in a genetically different type of bone.

Infections within a petrous apex have a much greater tendency to spontaneous cure, i.e. without the opening of the infected area, than has the associated mastoid suppuration, because in apical suppuration the infection is influenced by the presence of red bone marrow.

Clinical classification of infections of the petrous apex and sphenoidal basis. I propose a clinical classification, based on my experience with 42 cases of petro-apicitis and 24 cases of infection of the sphenoidal basis, as follows: (1) reactive and reparative osteitis; (2) non-suppurative congestive cases—symptoms due to venous stasis; (3) chronic bone sepsis cases (without macroscopical pus); (4) abscess of apex—(a) without a tract, (b) with a tract; (5) acute septicaemic cases, associated with a continuous positive blood culture and meningitis.

Intrameatal type of facial paralysis. There occurs a specific type of facial paralysis in petro-apicitis which is seen in no other process. This "suppuration of a facial" (an intrameatal type of facial paresis) is transient in duration and limited in extent. It is characterized by the partial non-closure of the lower lid during sleep, although the ability spontaneously to close the lid completely is not lost.

Meningitis from suppuration of the apex is at first limited to the cisterns (a) covering the floor of the middle fossa, or (b) mesial to the internal auditory meatus of the posterior fossa.

Infection of the sphenoidal basis. The pattern of blood supply within the red bone marrow accounts for the unique reparative and specific protective properties of the sphenoidal basis, also possessed, but to a lesser extent, by the petrous apices. It also explains the rarity of small sequestra in pyogenic lesions of an apex or of the sphenoidal basis.

A symptomless infection of the sphenoidal basis is a frequent, but generally overlooked, cause of meningitis, especially of the pneumococcal type. In pneumococcus Type II meningitis, I have cured cases by simply draining the sphenoidal sinus and by the administration of serum.

Control of infection by metaplastic reconversion from yellow (acellular) fat marrow into red (cellular) bone marrow. During infancy and childhood, all the bones of the torso and extremities are filled with red cellular bone marrow containing no fat. However none of the cranial bones, with the exception of the sphenoid, the occipital and the two petrous apices (which form the primordial basis of the skull) contain red bone marrow, although the bones of the tympano-antral area of the nasal accessory cavities which increase in size by pneumatization are, at birth, filled with yellow fat marrow. The red (cellular) marrow at osseous maturity subsequently is converted into yellow acellular fat. This metamorphosis from red into yellow fat marrow occurs in all red marrow containing bones, with the exception of the sphenoid, the segmental portion of the occipital, the vertebrae, the ribs, and the os innominatum, whose spongy tissue has a preponderance of red cellular bone marrow throughout life.

However if at any time an irritant, notably infection or cancer enters, or even indirectly affects a marrow containing bone, its yellow (acellular) fat marrow may become reconverted into red (cellular) marrow. This rapid metaplastic reconversion from yellow (acellular) fat marrow to its original state of red (cellular) bone marrow is, I believe, an evidence of the tissue mechanism which red marrow containing bones possess for the local control of infection.

Metaplastic reconversion from pneumatic air filled spaces into the original bone marrow state within an apex accounts for the infrequency of apical abscess. Primarily the petrous apex is a red (cellular) marrow containing bone, its red marrow being converted into fat or replaced by air filled cells early in life. It does not combat infection simply by pouring forth round polymorphonuclear cells brought to it by the circulation, as is the reaction of the mastoid to suppuration, but on the approach of infection the pneumatic spaces within the apex may return to their original bone marrow state. Thus it may become the seat of a unique physiological metamorphosis, to which attention has not been previously directed. This phenomenon I have observed in at least 2 cases, as demonstrated at postmortem examination.

Treatment of meningitis from apical or sphenoidal infection. If we are to be successful in the treatment of meningitis, we must abandon many of our pre-conceptions, for in the past all surgical treatment has been based too much on the principle of drain-

age of the entire arachnoid circulation, which is impossible.

In my opinion, operation on the meninges, if preceded by ligation of the common carotid artery gives a higher percentage of recoveries than other wise, because carotid ligation relieves venous congestion, which postmortem examinations show to be invariably present in all cases of meningitis.

In the surgical treatment of meningitis it is of paramount importance that the surgeon should early

diagnose and thoroughly drain the primary focus of infection in the petrous apex or in the sphenoid—lesions that are curable for eradication of a primary focus in a bone, associated with the evacuation of an adjacent localized collection of infected cerebrospinal fluid, allows the protective and reparative mechanism of the meninges an opportunity to act. This procedure has been followed by a larger percentage of recoveries than any other method of treatment, either surgical or medicinal.

NON-OPERATIVE TREATMENT OF NASAL SINUS DISEASE¹

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THE treatment of chronic nasal sinus disease in a non-operative manner is, in the majority of instances, an unsatisfactory procedure. We must, therefore when attempting this method of treatment select our cases with discretion and not continue to treat for any length of time a patient who is in need of a more radical procedure. We shall eliminate immediately from our discussion the treatment of all very acute inflammatory processes of the nose and nasal accessory sinuses whether associated with fever or not. We believe that any local treatment at this time unless it be the application of a vasoconstrictive agent will only kindle the fire and be the cause of a reaction and a spread of the disease.

The chief consideration will, therefore be the subacute and chronic infections. How shall these patients be treated non-surgically? In the first place let it be said that no one fixed plan of treatment can be used in all cases. The various means and methods of treatment which we have employed in our practice are the following: systemic treatment of the nasal mucosa, median rhinoscopy, treatment of nasal recesses, tampons suction with irrigation, dilatation of the ostia and nasofrontal duct, irrigation of the sinuses, and infra red and ultraviolet therapy.

We may rightly say that the most difficult problem before the medical profession today is the study of the constitution of the patient, inasmuch as each individual reacts to certain irritants according to the character of his inner qualities, and these qualities we term constitution. It is our belief that the treatment of the constitution of the patient with diet, hygienic measures of living, endocrine and intestinal therapy, and the examination of the blood for various changes is of greater importance than the detection of the type and virulence of the bacteria. To emphasize the bacterial aspect only and give vaccines specific or non-specific, is not sufficient. We must not forget that the bacteria would probably not have been present if the constitutional elements of the patient had not been ready to receive them.

A patient in whom the constitutional elements are inadequate to combat infection readily acquires a chronic state of the nasal sinus mucosa following an acute infection. In these patients, two physiological functions are easily lost, namely movement of the ciliated epithelium, and secretion of mucus—both very important functions when infection takes place. A patient whose tissues are unable to perform their physiological function at the time of an infection is left with an oedematous nasal mucous membrane which may cause retention in the recesses—a favorable condition for the establishment of chronicity.

An acutely inflamed maxillary sinus should rarely if ever be irrigated in the presence of fever, because of the danger of causing a systemic infection following the lavage. Patients are usually able to combat the infection in an antrum, provided no other irritant appears upon the scene such as the irritation which may be caused by an antrum lavage. As soon as another insult is added to the infection already present in the antrum an imbalance of the body mechanism takes place. The bacteria gain the upper hand and many times, because of the injury to the mucous membrane from puncture a secondary inflammation ensues and a local or general sepsis may be the result.

In applying the various forms of treatment, both local and general, we must forget for the time being at least, that we are rhinologists limited to a small specialized field. We must try to be real doctors who are making a special study of a very sensitive part of the body—the nose and its adnexa—areas which are affected very readily by a systemic dyscrasia.

A hasty surgical approach is, in our opinion, a great mistake. Surgery in most instances, should be undertaken only after a careful analysis has been made or should follow the conservative treatment after this has proved of no avail. When surgery is necessary its success will depend on the ability of the surgeon to detect every affected sinus, and his accuracy in removing all of the diseased mucous membrane.

THE OPERATIVE TREATMENT OF NASAL SINUS DISEASE¹

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A DISCUSSION of the operative treatment of nasal sinus disease necessitates correlating various technical endeavors, some as yet unpublished and evaluating methods and hoped-for improvements in treatment with which I have been continuously occupied since the publication of my original article entitled "Fronto-Ethmo-Sphenoid Operation under Local Anesthesia," in the *Archives of Otolaryngology* in 1926. I am inclined to quote as follows from that article because what was said then needs even more emphasis today.

Indications for operation. The operative treatment of sinus disease is a subject that I feel should be approached with considerable caution. I am proposing a rather radical line of procedure that I feel may add to our efficiency in handling certain cases. Still I do not wish to leave the impression that I am applying these measures except after careful study or when former unsuccessful operative work would seem to make their applicability advisable. I have gone into the question of diagnosis frankly but must make the point plain that the diagnosis arrived at does not condemn the patient to operative measures. It becomes a matter of the nicest judgment on the part of a well trained surgeon, probably with the invaluable assistance of the internist, to determine whether the sinuses should be operated on. A rubric of the operative indications would only be about as useful as those that have been compiled to tell us when to operate on a chronic running ear. Many people with apparently excellent health are sufferers from infected sinuses. The hacking and spitting that is so commonly heard, and the mucopurulent expectoration seen on our city pavements, are evidence of the widespread distribution of sinus disease. While admitting that many people seemingly well are carriers of this infection, it is obvious that they are apparently in good health in spite of the sinuses. It is a menace constantly carried about, and often proves to be the vulnerable heel of Achilles, leading to the establishment of some important vital disorder. The inability to discover the true focus, the removal of a wrong focus or the incomplete treatment of the right focus have brought a certain amount of approbrium on the focal infection theory. Incomplete treatment of the right focus is practiced so commonly in connection with sinus disease, that the specialists must take the onus of the lack of understanding of the importance of sinus infection on the part of many of the medical profession. These men have conscientiously and repeatedly referred patients for elimination of nasal infection. Failure after nasal sinus operation to cure the disorder in which the internist was interested, very frequently has been interpreted as indicating improper diagnosis. The use of the method I have advocated of gathering the nasal and post-nasal discharges from the patient on pieces of cloth will show the internist himself whether the results he has asked for have been achieved.

Ordinarily before operation on the sinuses is to be considered, all other factors that may be contributing to the trouble should be corrected, climate has been given especial prominence. Whatever therapeutic measures have been found useful may be employed.

Constructive surgery when indicated, including submucous resection, tonsillectomy, and adenoidectomy should be given precedence and followed by sufficient time for accomplishment of results before the destructive surgery of the sinuses is advocated.

In presenting my present operative plan, it may be said that the intricate technical developments have followed naturally upon the introduction of a bloodless technique. This was accomplished by ligation of the vessels supplying the operative field, under local anesthesia secured largely by blocking the nerves before or at their entrance into the field.

Sinus surgery may well be divided into a pre- and a post ligation period. Prior to the introduction of these methods, general anesthesia was commonly used in external sinus technique.

The literature contains many descriptions of the bloody operative field where all nicety of technique was impossible.

The operative steps may be briefly summarized as follows:

1. The patient lies on the back, semiconscious from the effects of sodium amytal, scopolamine and morphine.

2. Cocaine is applied topically in the nose.

3. Novocain is injected deep into the orbit to block the nasal branches of the fifth nerve supplying the operative field.

4. A small incision at the inner angle of the orbit suffices, and leaves practically no scar.

5. The frontal sinus and the ethmoids are entered through a window cut through the frontal and maxillary bones.

6. The ethmoid vessels are ligated in the orbit.

7. The frontal and ethmoid sinuses are thoroughly inspected and cleared of disease.

8. The sphenopalatine artery is tied, permitting the intricate sphenoid technique.

9. A posterior submucous resection allows the removal of the whole of the floors of both sphenoids.

10. Flaps prepared from nasal mucosa are used to line the operative fields and prevent the closure of the nasofrontal drainage opening.

11. The wound is closed at once with metal clips, no packing, no bandage whatever.

CANCER OF THE LARYNX, INTRINSIC, ITS SURGICAL CURE¹

GABRIEL TUCKER, M.D., PHILADELPHIA, PENNSYLVANIA

THE clinical incidence of cancer of the larynx is apparently much greater than the incidence indicated by the rate of deaths from laryngeal cancer. The rate of laryngeal cancer deaths is given as 0.8 per cent, deaths from cancer of the esophagus 1.5 per cent, and deaths from cancer of the lung as 2.1 per cent of all cancer deaths. In a bronchoscopic practice, where the work is limited to the diagnosis and treatment of diseases of the larynx, esophagus, and lungs there were seen during the same period 200 cases of cancer of the larynx, 250 cases of cancer of the esophagus and 57 cases of cancer of the lung. With the present perfection of methods of early diagnosis, resulting in the surgical cure of at least 80 per cent of the early cases, the percentage of deaths from cancer of the larynx can no longer be taken as the true rate of incidence of laryngeal cancer.

Symptoms. In the consecutive series above noted of 200 cases of laryngeal cancer (1) it was found that every patient manifested either *chronic hoarseness* or *local discomfort* or both *chronic hoarseness* and *local discomfort* early in the course of the disease. In this study there were 144 cases (72 per cent) which were apparently of intrinsic origin. Chronic hoarseness was an early symptom in every case, but in many cases when the patients were first seen the lesions were far advanced and presented one or more of the signs and symptoms of inoperable cancer, namely dyspnea, dysphagia, aphonia, adenopathy. If the symptoms of chronic hoarseness and local discomfort were properly evaluated and routine diagnostic studies done in every case, cancer of the larynx would be found while the lesion was still early and curable by surgery.

Diagnosis. Cancer of the larynx appears as a definite local lesion and when far advanced, has a characteristic appearance. In its beginning the appearance of the lesion is rarely characteristic, and in fact the lesion may not be cancer. Clinically we must recognize that there is a precancerous lesion in many cases. To the trained eye of the expert laryngologist the typical lesion may be recognized as cancer from the appearance alone. However, we are not justified in waiting until this characteristic appearance develops to make a diagnosis of laryngeal cancer. Even when the appearance is definitely characteristic, a final diagnosis should not be made until after a thorough routine examination, serological study and X-ray examination of the neck and chest, have been done, and the finding of cancer has been confirmed by biopsy. As an example of the inadequacy of diagnosis without biopsy may be cited the case of a laryngeal cancer typical in appearance which on biopsy showed both cancer and tuberculosis (2).

Biopsy. The removal of tissue for histological examination by direct laryngoscopy has reached a

state of perfected technique that makes the procedure harmless if it is properly done. The reason we have not been able to cure more cases of cancer of the larynx by surgery in the past lay not with us but with those general practitioners and otolaryngologists who were afraid of biopsy and refused to have tissue removed until the appearance was characteristic, and the lesion hopelessly late. Biopsy of a non-cancerous growth in the larynx will not cause it to become cancer. Neither will biopsy propagate cancer in the larynx where it already exists if the proper course is followed. With the present technique a histological diagnosis based on a fixed specimen of tissue may be obtained within 48 hours, and surgical treatment can be promptly carried out. The lymphatic drainage within the larynx is such that there is no probability of metastatic extension within this short period.

Treatment. "Early diagnosis is the pearl without price in the surgical cure of cancer of the larynx." (3) Laryngofissure and total laryngectomy are the surgical procedures of choice in the treatment of cancer of the larynx.

Laryngofissure. Cancer within the larynx, intrinsic, is the most favorable type for surgical treatment. If the cancer involves the anterior two-thirds of the vocal cord—the most frequent site of origin—and has not extended beyond this, laryngofissure will cure over 85 per cent of the cases. If the growth involves the anterior commissure and both cords in the anterior portions, laryngofissure by a special technique for anterior commissure growths will result in cure in an equally high percentage of cases. Laryngofissure saves the patient's larynx as well as his life. A subperichondrial resection of the diseased area with a wide margin of normal tissue surrounding it is all that is required in properly selected cases of laryngeal cancer because the peculiar lymphatic drainage in the anterior portion of the larynx prevents rapid extension of the disease. The cartilage is not removed unless it is involved. The procedure can be carried out under local anesthesia and there should be no operative mortality. Following laryngofissure the larynx must be kept under close observation for at least a year. If granulations appear at the site of excision of the growth they should be removed by direct laryngoscopy and submitted to histological examination. If there should be recurrence of the cancer—the rate of recurrence is less than 15 per cent—laryngectomy can still be performed with a probable cure of 90 per cent of the recurrences.

Laryngectomy. Total laryngectomy should be done when there is more extensive involvement. Where the disease originates in the posterior portion of the larynx, or extends subglottic, or involves the ventricular bands or the base of the epiglottis, total

¹Abstract of paper presented before the Section on Otolaryngology, Clinical Congress of the American College of Surgeons, Boston, October 9, 1914.

laryngectomy is required. In cases in which the under surface of the epiglottis only is involved, the epiglottis can be removed completely by a laryngofissure approach; the remainder of the larynx being preserved.

The surgical procedure selected for the individual case depends on two factors: (1) the location and extent of the lesion, (2) the grading of the cancer cells in the growth.

The location and extent of the lesion is determined by careful mirror examination, by X-ray examination of the neck and chest, including the larynx and esophagus, and by direct inspection of the larynx, pyriform sinuses and upper esophagus before operation. After the larynx is opened the lesion also is carefully examined.

Cell grading is of greatest importance in determining the radiosensitiveness of the cancer; post-operative irradiation may be of great value in radio-sensitive types of cancer. Pre-operative irradiation is regarded as inadvisable by most laryngeal surgeons.

SUMMARY

1. The incidence of cancer of the larynx seems to be relatively greater than the rate of cancer deaths indicates. Because of the early diagnosis and the surgical cure of a large number of cases, the death

rate cannot be taken as a true indication of the incidence of laryngeal cancer.

2. Chronic hoarseness and local discomfort are always early symptoms in cancer of the larynx.

3. Biopsy by direct laryngoscopy, should be the final diagnostic step in cancer of the larynx. Biopsy will not produce cancer; and where cancer exists and biopsy is done. If the proper routine is followed, surgical removal of the cancer can be carried out before metastasis can occur.

4. Surgical treatment, laryngofissure and laryngectomy will cure practically all cases of intrinsic cancer of the larynx. Laryngofissure in properly selected cases will save the larynx as well as the patient's life. Educating the laity and the general practitioner to recognize that local discomfort and chronic hoarseness may mean cancer is the best most important step in the cure of cancer of the larynx.

REFERENCES

1. TUCKER, GABRIEL. Observations on two hundred consecutive cases of cancer of the larynx. *Tr. Am. Laryngol. Rhin. & Otol. Soc.* 1934.
2. Idem. A case of chronic hoarseness (ulcerative laryngitis) showing tuberculosis and cancer in the same lesion. *J. Am. M. Ass.* 1931; 96: 1572 and 1573.
3. THOMPSON, SIX, STICKLER, and COLLINGS, LORAIN. *Cancer of the Larynx*. London: Macmillan Company.

PATHWAYS OF APPROACH TO THE PETROUS PYRAMID¹

MARVIN F. JONES, M.D. New York, New York

IN studying surgical methods for the relief of petrositis, it becomes necessary to focus attention on the intimate anatomical structure of the temporal bone. Pneumatized tracts are of major importance.

More attention has been attracted to the acute phases, while the chronic stages with acute exacerbations are less widely recognized.

All operative procedures (with one exception) aim at the superior group of cells, while the logical method of drainage would seem to be through dependent portions of the bone.

The symptomatology developed recently would seem to indicate the extent and location of pathological changes, thus facilitating an intelligent choice of surgical procedures.

Impaired hearing and labyrinthine symptoms plus location of pain are proposed as indicative symptoms.

A discussion of the surgical procedures already advocated, and the difficulties found by personal experience illustrate some of the pitfalls.

Histological sections, X-ray pictures, and gross dissections illustrate the statements embodied in the paper.

Abstract of paper presented before the Section on Otolaryngology, Clinical Congress of the American College of Surgeons, Boston, October 4, 1934.

COMMITTEE AND DEPARTMENT REPORTS

DEPARTMENT OF CLINICAL RESEARCH—ALBERT J OCHSNER MEMORIAL

BOWMAN C. CROWELL, M D CHICAGO ILLINOIS
Associate Director American College of Surgeons, Director of Clinical Research

THE work in clinical research which is being conducted by the College includes that of the following committees

Committee on the Treatment of Malignant Diseases
Committee on the Archives of Malignant Diseases

Committee on Bone Sarcoma
Committee on Clinical Laboratories
Committee on Fractures

A survey of the work of this department which has been performed during the past year is embraced in the reports of the individual committees

COMMITTEE ON THE TREATMENT OF MALIGNANT DISEASES

CHARLES A. DUKES, M D OAKLAND CALIFORNIA, Chairman

THIS Committee, founded in 1922 has made a consistent study of records and clinics with the hearty co-operation of the surgeons pathologists and radiologists, throughout the United States and Canada.

Standard uniform record forms have been designed by the Committee, which have been used widely and adopted by cancer clinics, and hospitals where cancer clinics have not yet been formed. In 1930 the standard for organization and conduct of cancer clinics was formulated by the Committee and adopted by the Board of Regents. The wide acceptance of this standard of hospitals in the United States and Canada has been a pleasing result of the College activity and the figures indicating the growth of the movement will be presented at this meeting by the Director of Clinical Research.

The report of this Committee would not be complete without an acknowledgment of appreciation for the work of Dr Robert B. Greenough, who has been Chairman from the beginning until this year. The amount of time which he has spent and the skill which he has shown in completing the organization and in working through the mass of reports and forms which have been necessary to the completion

of this program I am sure will be appreciated by everyone, and there is considerable fear on my part that I shall be unable to live up to the high standards which his leadership has created.

It is also fitting that we should pay tribute to that great physician and surgeon who devoted so much of his life to this work—Dr Burton J. Lee, whose passing to the Great Beyond occurred shortly after the 1933 meeting.

The personnel of the Committee on the Treatment of Malignant Diseases is as follows:

Charles A. Dukes, Oakland, Chairman
Bowman C. Crowell, Chicago, Secretary
Frank E. Adair, New York
A. C. Broders, Rochester, Minn.
Curtis F. Burnam, Baltimore
George Crile, Cleveland
Edwin C. Ernst, St. Louis
Rupert H. Fike, Atlanta
John M. T. Finney, Baltimore
Robert B. Greenough, Boston
Frank W. Lynch, San Francisco
Alton Ochsner, New Orleans
Eugene P. Pendergrass, Philadelphia
George Gray Ward, New York
Francis C. Wood, New York

STANDARDIZATION OF CLINICAL LABORATORIES

AT the meeting of the Committee on the Standardization of Clinical Laboratories, held in October 1936 the following Minimum Standard for Laboratories was adopted and has been approved by the Board of Regents:

1. That the clinical laboratory shall be under the direction of a graduate in medicine, especially trained in clinical pathology.
2. That the clinical laboratory shall be prepared to perform satisfactory work in (a) histopathology (b) bacteriology and parasitology (c) serology (d) hematology and (e) chemical and morphologic examinations of other body fluids, exudates, transudates, and excreta.
3. That all tissues removed at operation shall be

examined in the laboratory and reports rendered thereon.

4. That an easily available copy of all reports shall be filed in the laboratory and one with the patient's record. In histopathology there shall be in the laboratory a cross index of at least the name of the patient, of the hospital or laboratory number of the patient, and of the lesion or organ. There shall be preserved also for at least 3 years, either section, embedded tissue or gross tissue from each case from which tissue is removed.

5. That a uniform system of charges for laboratory work shall be enforced.

6. That the clinical pathologist shall attend the monthly staff conferences of the hospital.

CANCER CLINICS APPROVED TO OCTOBER 1, 1934

IN 1930 the Board of Regents of the American College of Surgeons, on the advice of its Committee on the Treatment of Malignant Diseases, announced its policy of emphasizing the necessity of making the benefits of contemporaneous knowledge of cancer available to each and every cancer patient in the country. Already existing hospitals were recognized as the natural centers in which modern diagnostic and therapeutic procedure should be conducted, and a minimum standard was formulated for cancer clinics in such hospitals.

Information concerning the cancer clinic movement of the College was published, and all approved hospitals of one hundred or more beds were urged seriously to consider cancer clinic organization. Representatives of the College have visited the hospitals, have consulted with members of their medical staffs and administrators, and have furnished to the College a summary of the activities of each hospital with regard to the diagnosis and treatment of cancer. Ordinarily these hospitals have the personnel and equipment for such service, but we believe that a definite organization for this special service is of advantage in obtaining the maximum of efficiency in the campaign against cancer.

The College announces its second list of the hospitals conducting cancer clinics which conform to its minimum standard. The conduct of such clinics varies somewhat according to the character of the hospital with regard to whether its patients are charity patients or otherwise. Some institutions have established diagnostic clinics but refer the patients elsewhere with advice as to the nature of treatment that should be administered. In certain other large institutions some departments have organized cancer clinics for the recognition and care of cancer in their patients while other departments have not so organized. Cognizance of these facts is taken in the publication of the list of institutions that

are approved from the standpoint of their cancer clinics.

It is further recognized that certain institutions have accepted the minimum requirements for cancer clinics as formulated by the American College of Surgeons and are endeavoring to carry them out, but for lack of time or other acceptable reasons have not yet been able to do so in every detail. In the following list they are indicated as having "provisional approval."

Total cancer clinics surveyed	239
Approved cancer clinics in general hospitals	97
Provisionally approved cancer clinics in general hospitals	55
Approved cancer diagnostic clinics	23
Hospitals with departments conducting approved cancer clinics	6
Total approved cancer clinics	181

The publication of the list of 181 approved cancer clinics in no way indicates that effective cancer treatment cannot be obtained elsewhere, but serves to show that these institutions have formally organized for this purpose as part of a country wide campaign in behalf of the cancer patient.

In addition to the list of approved cancer clinics the College has information concerning 53 others which for one reason or another are not yet ready for a rating by the College, and still 80 other hospitals have definitely signified their contemplation of the formation of such clinics in the future.

MINIMUM STANDARD FOR CANCER CLINICS IN GENERAL HOSPITALS

1. *Organization.* There shall be a definite organization of the service, and it shall include an executive officer and representatives of all the departments of

the hospital which are concerned in the diagnosis and treatment of cancer. The services of a secretary and of a social service worker shall be available.

2 *Conferences* As an essential feature of the service there shall be regular conferences or consultations at which the diagnosis and treatment of the individual cases are discussed by all members of the clinic who are concerned with the case.

3 *Patients* Reference to the cancer clinic of all patients in whom the diagnosis or treatment of cancer is to be considered shall be either voluntary or obligatory in accordance with the vote of the medical staff or of the governing board of the hospital.

4 *Equipment* In addition to the diagnostic and therapeutic surgical equipment which is required in every approved general hospital there shall be available an apparatus for X ray therapy of an effectiveness which is generally agreed upon as adequate, and an amount of radium sufficient to insure effective treatment.

5 *Records* In addition to the records which are required in every approved general hospital, there shall be additional records of (a) the details of the history and of the examination for cancer in different regions of the body, such as are indicated on the form records which are recommended by the Committee on the Treatment of Malignant Diseases, American College of Surgeons, (b) the details of the treatment by radium or X ray as indicated on the form records which are recommended by the Committee on the Treatment of Malignant Diseases, of the American College of Surgeons, (c) periodic examinations at intervals for a period of at least five years following treatment.

6 *Treatment* The treatment of cancer patients shall be entrusted to the members of the staff of the cancer clinic except in cases in which adequate treatment in accordance with the collective recommendation of the staff of the cancer clinic can be procured otherwise.

HOSPITALS CONDUCTING APPROVED CANCER CLINICS

UNITED STATES

ARIZONA

PHOENIX—*St. Joseph's Hospital

CALIFORNIA

LOS ANGELES—*California Hospital
Hollywood Clara Barton Memorial Hospital
Veterans Administration Hospital
OAKLAND—Highland Hospital of Alameda County
PASADENA—*Pasadena Hospital
SAN DIEGO—San Diego County General Hospital
SAN FRANCISCO—*University of California Hospitals
SANTA BARBARA—*Santa Barbara Cottage Hospital
WOODLAND—*Woodland Clinic Hospital

COLORADO

DENVER—*St. Luke's Hospital
*Colorado General Hospital

CONNECTICUT

BRIDGEPORT—Bridgeport Hospital
HARTFORD—Hartford Hospital
*St. Francis Hospital
NEW HAVEN—New Haven Hospital
WATERBURY—Waterbury Hospital

DELAWARE

WILMINGTON—Delaware Hospital
*Wilmington General Hospital

DISTRICT OF COLUMBIA

WASHINGTON—*Freedmen's Hospital
Garfield Memorial Hospital
Georgetown University Hospital
Providence Hospital

Previously approved

FLORIDA

MIAMI BEACH—St. Francis Hospital

GEORGIA

ATLANTA—Albert Steiner Clinic
THOMASVILLE—John D. Archbold Memorial Hospital

ILLINOIS

CHICAGO—Cook County Hospital
Mercy Hospital
Michael Reese Hospital
*St. Luke's Hospital
University of Chicago
HINES—Veterans Administration Hospital

KANSAS

KANSAS CITY—Bell Memorial Hospital

KENTUCKY

LOUISVILLE—John N. Norton Memorial Infirmary
St. Joseph's Infirmary

LOUISIANA

NEW ORLEANS—*State of Louisiana Charity Hospital
SHREVEPORT—Shreveport Charity Hospital

MAINE

PORTLAND—Maine General Hospital

MARYLAND

BALTIMORE—Howard A. Kelly Hospital
University Hospital of the University of Maryland

MASSACHUSETTS

BOSTON—Beth Israel Hospital
Collis P. Huntington Memorial Hospital
Massachusetts General Hospital
Palmer Memorial
Peter Bent Brigham Hospital

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WEST VIRGINIA

CHARLESTON—*Mountain State Hospital

WISCONSIN

MADISON—State of Wisconsin General Hospital

MILWAUKEE—Columbia Hospital

CANADA

ALBERTA

EDMONTON—*University of Alberta Hospital

MANITOBA

ST. BONIFACE—St. Boniface Hospital

WINNIPEG—Winnipeg General Hospital

NEW BRUNSWICK

SAINT JOHN—*Saint John General Hospital

NOVA SCOTIA

HALIFAX—Victoria General Hospital

ONTARIO

KINGSTON—Kingston General Hospital

LONDON—Victoria Hospital

OTTAWA—Ottawa Civic Hospital

TORONTO—Toronto General Hospital

QUEBEC

MONTREAL—Hopital Saint Luc

Institut du Radium

Montreal General Hospital

SASKATCHEWAN

REGINA—Regina General Hospital

SASKATOON—City Hospital

CHINA

PEIPING—Peiping Union Medical College Hospital

HOSPITALS CONDUCTING APPROVED CANCER DIAGNOSTIC CLINICS

ARIZONA

TUCSON—St. Mary's Hospital and Sanatorium

CALIFORNIA

SAN FRANCISCO—Mary's Help Hospital

ILLINOIS

CHICAGO—Northwestern University

MASSACHUSETTS

BOSTON—Boston Dispensary

LAWRENCE—Lawrence General Hospital

LOWELL—Lowell General Hospital

LYNN—Lynn Hospital

MICHIGAN

DETROIT—St. Mary's Hospital

MISSOURI

FULTON—Fulton State Hospital

NEW HAMPSHIRE

HANOVER—Mary Hitchcock Memorial Hospital

MANCHESTER—Elliot Hospital

NASHUA—St. Joseph's Hospital

NEW JERSEY

ATLANTIC CITY—Atlantic City Hospital

NEW YORK

BAY SHORE—Southside Hospital

MIDDLETOWN—Elizabeth A. Horton Memorial Hospital

WATERLOO—House of the Good Samaritan

Mercy Hospital

OHIO

COLUMBUS—Columbus Cancer Clinic

PENNSYLVANIA

ALLENTOWN—Allentown Hospital

LANCASTER—St. Joseph's Hospital

NORRISTOWN—Montgomery Hospital

PHILADELPHIA—Frankford Hospital

WILKES-BARRE—Mercy Hospital

HOSPITALS IN WHICH DEPARTMENTS ARE CONDUCTING APPROVED CANCER CLINICS

MICHIGAN

DETROIT—Henry Ford Hospital

NEW YORK

NEW YORK—Presbyterian Hospital in the City of New

York
Roosevelt Hospital

OHIO

CLEVELAND—Lakeside Hospital

TENNESSEE

NASHVILLE—Vanderbilt University Hospital

CANADA

QUEBEC

MONTREAL—Royal Victoria Hospital

REGISTRY OF BONE SARCOMA

BOWMAN C. CROWELL, M.D. CHICAGO, ILLINOIS, Registrar

THERE have been 197 cases submitted to the Registry during the past year. Of these 161 cases have been registered.

Of 537 of the cases which have been circulated during the year opinions have been rendered by 33 doctors.

The total number of cases in the Registry is now 1703 classified as follows:

Osteogenic sarcoma	773
Ewing's sarcoma	171
Myeloma	73
Lymphosarcoma	8
Inflammation	89
Periosteal fibrosarcoma	27
Metastatic tumor	46
Angioma	13
Hemangio-endothelioma	14
Benign giant cell tumor	313
Giant cell tumor malignant	18
Benign osteogenic tumor	58
Unclassified and miscellaneous	70
Not bone tumors	21
Parosteal osteogenic sarcoma	4
Liposarcoma	4
Xanthoma	1
Parosteal Fibrolipoma	2

1703

There are 504 cases of osteogenic sarcoma that were treated 5 years or more ago and 126 cases of Ewing's sarcoma that were treated 5 years or more ago.

In March, 1926, Dr. Ernest Amory Codman, the originator and first Chairman of the Registry of Bone Sarcoma, published 25 criteria for establishing the diagnosis of osteogenic sarcoma and 13 registered cases of 5 year cures analyzed according to these criteria.

From time to time since then the Registrar has announced an increasing number of such "5 year cures" that have been registered. The present report presents 74 cases of osteogenic sarcoma and 10 cases of Ewing's sarcoma that have lived clinically free from the disease for periods of 5 years or more following treatment.

Three of the original 13 cases reported by Dr. Codman died. B. S. R. No. 100 died 11 years after treatment with metastases in the spine, ribs and lungs after having been clinically free of the disease for 10 years or more. B. S. R. No. 30 died of paralysis 24 years and 9 months after treatment. B. S. R. No. 29 died from cancer of the breast 17 years and 5 months after treatment. The other 10 original "cures" are still alive and free from the disease at the time of the latest report.

Five of the other cases here reported have died after the expiration of the 5 year period. B. S. R.

No. 1437 from cardiac and cerebral sclerosis, B. S. R. No. 176 following a prostatectomy. B. S. R. No. 970 with probable pulmonary metastases 8 years after treatment. B. S. R. No. 156 9 years after treatment from heart disease without recurrence of the tumor and B. S. R. No. 1035 from metastases.

At least 3 cases (B. S. R. Nos. 183 and 367) have had definite evidence of metastases which have disappeared after treatment.

Seventy-one of the 74 five year cures of osteogenic sarcoma were treated by surgical methods, and of these 39 had surgical methods only. In the other 35 cases surgery was supplemented by radium or X ray treatment or Coley toxins or some combination of these agents. In 16 of the cases Coley toxins were administered.

The cases in which amputation was not performed are as follows:

B. S. R. No. 668 Local excision of tumor of lower part of femur followed by radium.

B. S. R. No. 183 Local excision of tumor of lower part of tibia followed by radium and Coley toxins.

B. S. R. No. 533 Excision of tumor of ilium followed by radium.

B. S. R. No. 585 Tumor of ilium treated by X rays only.

B. S. R. No. 109 Tumor of rib treated by resection followed by radium.

B. S. R. No. 373 Tumor of rib was explored and then treated by radium and Coley toxins.

B. S. R. No. 759 Tumor of scapula treated by excision and X rays.

B. S. R. No. 867 Tumor of scapula treated by excision alone.

B. S. R. No. 1523 Tumor of humerus treated by excision alone.

It is interesting to note that 20 of the cases had some form of operative procedure on the tumor at periods of 1 day to 5 years prior to amputation. These operative procedures consisted of single or multiple biopsies, curettages, explorations, excisions or resections.

There are in the Registry 504 cases of osteogenic sarcoma that were treated 5 years or more ago. No figures are included in this report to show the percentage of cures for the reason that this series does not represent a consecutive series of cases treated, and moreover there is a tendency for doctors to pay more attention to the registration of their unusually successful cases than to a registration of all of their cases.

EWING'S SARCOMA

Ten of the registered cases of Ewing's sarcoma have lived from 5 to 21 years following treatment. These cases occurred in a group of 126 registered cases of this disease.

All 10 cases were subjected to surgery. In 7 of them amputation was performed. In the other 3 there were excisions. Six of the 7 amputated cases also received Coley toxins and of these, 5 had radiation in one form or another. Four of the 7 amputated cases had one or more surgical procedures at some period prior to the amputation.

The personnel of the Committee is as follows:

Dallas B. Phenister, Chicago, Chairman
Bowman C. Crowell, Chicago, Registrar

Edwin I. Bartlett, San Francisco
Everett L. Bishop, Atlanta
Joseph C. Bloodgood, Baltimore
Barney Brooks, Nashville
Ernest A. Codman, Boston
Charles L. Connor, San Francisco
James F. Fling, New York
W. R. Calbreath, Porto Rico
Frank W. Hartman, Detroit
Henry W. Meyerding, Rochester, Minn.
John J. Morton, Rochester, N. Y.
Channing C. Simmons, Boston

COMMITTEE ON FRACTURES

FREDERIC W. BANCROFT, M.D., New York, New York, Chairman

THE purpose of the Committee on Fractures is to stimulate interest in and improve the treatment of fractures. The Committee functions through three main channels: first, the Annual Meeting of the American College of Surgeons; second, the Annual Meeting of the General Committee on Fractures; third, Regional Groups.

1. At the Annual Meeting of the American College of Surgeons the Committee arranges for the fracture symposium and the fracture oration. It also gives practical demonstrations in recognized methods of fracture treatment and holds a clinical conference with members of the various regional groups.

2. The Committee meets in January of each year. The first day is given over to clinics wherein advances in the treatment of fractures are shown and the second day is devoted to reports of the various sub-committees. The sub-committees are as follows: (a) Scientific—presenting the latest advances in research or treatment; (b) Educational—both under graduate and postgraduate; (c) Regional groups; (d) Physical therapy; (e) Bone plates and screws; (f) American Railway Surgeons; (g) Editorial; (h) Transportation and ambulance equipment.

The Committee has concentrated its efforts during the past year on two main subjects: (1) the immediate application of traction at the site of injury following the dictum "splint them where they lie"; (2) the early reduction and improved treatment after the patient arrives at a hospital.

The application of immediate traction to long bone fractures has been more and more emphasized as high speed locomotion by automobiles and air planes has increased the number of serious injuries along highways. The deformities resulting from improper or no splinting during transportation not only delay the healing time of the fracture but also may cause serious shock, hemorrhage or death. Men experienced in the treatment of fractures are convinced that reduction before edema and swelling occur results in better replacement of fragments and hence diminished time of disability and better function when union has occurred.

Because of a limited time at my disposal, I shall report only on first the activities of the Committee

on Transportation, second, Editorial Committee, third, Regional Groups.

1. *Transportation*. A new edition of the American Red Cross First Aid Text Book is expected to appear within the next year. We have the assurance of their Director of First Aid and Life Saving that this new edition will contain the suggestion that fixed traction transportation be taught to all Red Cross classes, instead of simply to large groups, such as police, fire and industrial departments, as the present edition states. Instruction in this method is being continued actively before groups of approved Red Cross instructors and it is expected that within a year and a half all instructors will have been prepared to teach this method. In 1930 a pamphlet was sent out by the Red Cross to all chapter chairmen outlining a procedure for establishing first aid posts on the highways. On account of the economic depression this work has been held largely in abeyance. As soon as business improves they expect to enter actively into this field again.

The major portion of transportation of the injured in the country as a whole is done by the undertakers. One of their national organizations sent out a questionnaire on this subject prepared by the sub-committee to its entire membership. Replies were received from about 70 per cent. Of these about 70 per cent were in favor of adopting fixed traction for use on their ambulances and said they were ready to do so if they could be trained. The other large national organization of funeral directors is considering adoption of the method through its Committee on Education.

Many police and fire emergency squads have been trained and are using the method as a routine, also some mines and industrial plants which have their own first aid crews.

An important new contact, largely through the efforts of Dr. Thomson of Lincoln, Nebraska, has been made with the National Council of the Boy Scouts of America. Dr. Owen and Dr. Scudder have been of great assistance in this. Mr. Fred C. Mills, National Director of Health and Safety Service, is enthusiastic in his efforts to educate his personnel in fixed traction. At their annual meeting in June

1934 a demonstration of the application of the Thomas splint was given before the heads of their professional staff. About 30 men were present from all parts of the country. At Mendham, New Jersey they maintain national training headquarters for professional scout leaders. They are key men whose duty it is to teach the scout masters throughout the country. At the last two schools demonstration of fixed traction has been given to about 50 men. Mr. Mills personally has given demonstrations to 4 group meetings of scout masters in New York, New Jersey, Ohio and Minnesota.

Before the Boy Scout Camps opened in the summer of 1934 a bulletin was sent from their National Headquarters asking all Scout executives to buy or borrow and place in their camps, a set of Thomas splints. There are about 500 of these camps in the United States. Dr. Thomson has prepared a description of the application of fixed traction illustrated with excellent photographs of Boy Scouts carrying out the procedure. The Boy Scouts is an organization of about 650,000 boys, 300,000 men, and 30,000 training instructors. We believe that this contact is one of the most important we have made in that it will be a constant means of educating the general public to demand of the medical profession proper fracture transportation. The National Organization of the Boy Scouts has agreed to do its utmost to further our campaign.

2. *Editorial committee.* The fracture manual was originally sent out in 15,000 pamphlets and has had since that time two printings in a revised form, 3,000 in the first and 2,000 in the second edition. Of these the greater number were distributed in the United States but in addition they were distributed in 20 countries outside the United States and Canada. The Professor of Surgery in the University of Australia asked for the privilege of incorporating The Outline in a pamphlet which he would issue to the students.

3. *Regional groups.* The regional groups function through clinical meetings in hospitals, executive meetings, and travel trips to various clinics. In Boston the regional group has done a great deal to stimulate education throughout the greater part of New England and to improve the treatment of fractures in the various hospitals in Boston. In New York, through the efforts of the local group the commissioner of hospitals ordered that Thomas splints for leg and Murray Jones splints for arm fractures be made a part of the equipment of every ambulance caring for city patients. Through the efforts of this group courses of instruction in fracture treatment for internes have been started in many of the municipal hospitals. In Philadelphia the regional group has instructed firemen, hospital internes, and Boy Scouts in immediate traction and has obtained the necessary equipment for their ambulances. In Chicago the group gave excellent clinical demonstrations at the last meeting of the American College of Surgeons. The University of Chicago has taken over the Provident Hospital, a hospital for colored patients in

Chicago as a graduate school for negro physicians. Through the efforts of the local group fracture treatment has been emphasized, and they are making Thomas splints in their own shops at a cost of one dollar. From all over the state negro physicians are coming for postgraduate instruction. In Arizona the state group has instructed the state police so that the main highways are being supplied with splints and immediate traction is being initiated in injuries occurring along the state highways.

This, in brief, is a summary of the Committee's most important activities.

Dr. Darrach estimated a saving of \$100 per patient by the use of proper transportation of a fracture. It has been estimated that there are about 300,000 extremity fractures a year in this country. By the adoption of this method it would seem that there would be an economic saving of \$30,000,000 a year.

If we are to reduce the marked economic loss that is sustained by the average person with fractures of the extremities there must be a nation-wide campaign of medical education on the subject of fracture treatment. It has been said by Hiltzert that the average length of time that patients with fractures of the femur are kept from their normal occupation is about 14 months. This is by far too long a time. In order to improve fracture treatment public education must be carried on so that eventually we shall have stations along all highways and in main industries, where Thomas splints can be obtained readily. Groups of men must be trained in the application of these splints in a manner similar to that carried out during the war when large numbers of doughboys and stretcher-bearers were instructed in the application of immediate traction. The Thomas splint must be cheap enough and light enough so that it can be returned by parcel post to its original station or to a central warehouse.

These problems are vital to all of us. More regional groups should be organized and we need aid and advice in the formation of these groups.

STANDARD FOR MINIMUM EQUIPMENT FOR FRACTURE TREATMENT IN HOSPITALS

1. That all general hospitals be equipped to care for fractures that the minimum equipment for the transportation and emergency treatment of fractures be the following or its equivalent.

Thomas upper extremity splints Thomas lower extremity splints with traction straps, slings and buckle straps Hodgen splints coaptation splints, assorted sizes Cabot wire splints straight pieces of wood (of assorted length, width and thickness) for splints plaster-of-paris bandages, some form of overhead frame for suspension suitable X ray apparatus, including a portable machine, if practicable.

2. That it is highly desirable that one individual surgeon be responsible for the supervision of the care of fractures in each hospital service.

3. That special record sheets be used for fracture cases.

4. That a close follow up be maintained on all fracture cases for such time as necessary to establish an accurate knowledge of end results

The personnel of the Committee on Fractures is as follows

Frederic W. Bancroft, New York, Chairman

Robert H. Kennedy, New York, Secretary

Peter A. Bendixen, Davenport

Willis C. Campbell, Memphis

Isidore Cohn, New Orleans

H. Earle Conwell, Birmingham

Salvador Cordoba, Venezuela

Frederic J. Cotton, Boston

William R. Cubbins, Chicago

William Darrach, New York

Frank D. Dickson, Kansas City, Mo.

Eldridge L. Eliason, Philadelphia

William L. Estes, Jr., Bethlehem

W. Edward Gallie, Toronto

Fraser B. Gurd, Montreal

Donald Guthrie, Sayre

George W. Hawley, Bridgeport

Melvin Henderson, Rochester, Minn.

William L. Keller, Washington

Norman T. Kirk, Washington

Philip H. Kreuscher, Chicago

Samuel L. Ledbetter, Jr., Birmingham

Walter Estell Lee, Philadelphia

George A. Leland, Jr., Boston

Paul B. Magnuson, Chicago

Henry C. Marble, Boston

Clay Ray Murray, New York

Lloyd Noland, Birmingham

Hubley R. Owen, Philadelphia

Edwin W. Ryerson, Chicago

Charles L. Scudder, Boston

W. O'Neill Sherman, Pittsburgh

Ernst A. Sommer, Portland

Kellogg Speed, Chicago

Frederic J. Teca, Montreal

Jorge del Toro, Porto Rico

J. Huber Wagner, Pittsburgh

John B. Walker, New York

Roscoe C. Webb, Minneapolis

George E. Wilson, Toronto

John C. Wilson, Los Angeles

Philip D. Wilson, New York

MEDICAL SERVICE BOARD

ROBERT B. GREENOUGH, M.D. F.A.C.S. Boston, Chairman

THE Medical Service Board was authorized by the Executive Committee of the Board of Regents of the American College of Surgeons on July 15, 1933, and approved by the Board of Regents at the ensuing annual meeting. The Board was created for the purpose of formulating the general principles which could be established by the College for the guidance of its Fellows in relation to the many different projects for periodic prepayment plans for hospital and medical service, for contract medical service and for industrial and traumatic surgical services all over the country. A statement of such general principles was submitted by the Medical Service Board to the Board of Regents on June 10, 1934, and approved by them. This report was published in the June, 1934, Bulletin of the College. The inaugural address of the President of the Col-

lege at the Clinical Congress held in Boston in October 1934, dealt with this general subject.

Further reports of the Medical Service Board will appear in the quarterly Bulletins of the College in the official Journal—*SURGERY GYNECOLOGY AND OBSTETRICS* and in other channels of information.

The personnel of the Medical Service Board is as follows:

Robert B. Greenough, Boston, Chairman
 Bowman C. Crowell, Chicago, Secretary
 G. Harvey Agnew, Toronto
 Charles A. Duke, Oakland
 Franklin H. Martin, Chicago
 C. Jeff Miller, New Orleans
 Eugene H. Pool, New York
 Arthur M. Suplee, Baltimore
 J. Bentley Squier, New York
 S. Marc White, Minneapolis

BOARD ON INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FREDERIC A. BESLEY, M.D. WAUKEGAN, ILLINOIS, Chairman

IN submitting this report of the activities and accomplishments of the Board on Industrial Medicine and Traumatic Surgery may we say that it is believed that there is a growing interest in this branch of the educational program of the College on the part of leading industrialists. Dr. Newquist and Dr. Williamson are carrying on the survey of the industrial medical organizations with some very satisfactory results. They have surveyed 1,122 such medical organizations in industry and approximately 55 per cent of them have been listed for approval. It is gratifying to note the psychological force of the desire of the leaders in industry to receive the stamp of approval of the American College of Surgeons. Obviously this fact is an important and essential factor in our educational program to secure better medical and surgical service and supervision for the army of workers in industry.

The report of Dr. Newquist, Medical Service in Industry and Workmen's Compensation Laws, has attracted a great deal of attention and favorable comment. In this connection it may be stated that the National Council of Compensation Insurance Companies extended an invitation to Dr. Martin and myself to meet with them in a conference at New York in September for the purpose of discussing mutual problems. Dr. Frederic Cotton attended this meeting with us. This Council represents both stock and mutual companies. As a result of this meeting a

committee was appointed by the Insurance Council to confer with the representatives of the College for the purpose of securing a better quality of surgical service for those injured in industry. It is believed that this movement has far reaching potentialities for achievements in this branch of our work.

Last year the Conference on Industrial Medicine and Traumatic Surgery held at the annual meeting in Chicago was very well attended and elicited a great deal of interest. We have stressed the purely scientific side of the subjects for the program for this year's meeting believing that this policy promotes the largest educational accomplishments. The sectional meetings held during the past year were favored by a very large attendance. A considerable portion of the programs were devoted to a discussion of medicine and surgery in industry, and we were rewarded by an increasing amount of interest in this subject. This is particularly true of the community health meetings where the audiences ranged in number from 5,000 to 12,000 in each city. The value of this spread of knowledge to the laity cannot be overstated. Naturally the rumors that are being circulated of what the federal government may do in connection with the relief work as it concerns medical, surgical, and hospital service for the groups of lower financial incomes, are most interesting, but any conclusions at this time must be purely speculative and would not aid us in the formulation of our

own policies. It is believed that many industrial diseases, as exemplified by silicosis, will be covered by new compensation laws comparable to those prevailing in regard to trauma. Dr. Martin is contemplating further changes in the personnel of your Board on Industrial Medicine and Traumatic Surgery so as to make it a more efficient working unit.

We appreciate the splendid support that Dr. Martin, the Fellows and this Board have given us.

MINIMUM STANDARD

1. The industrial establishment shall have an organized medical department or service with competent medical staff including consultants and also shall have adequate emergency dispensary and hospital facilities and personnel to assure efficient care of the ill and injured.

2. Membership on the medical staff shall be restricted to physicians and surgeons who are (a) graduates from an acceptable medical school, with the degree of Doctor of Medicine in good standing and licensed to practice in their respective states or provinces, (b) competent in the field of industrial medicine and traumatic surgery, (c) worthy in character and in matters of professional ethics in the latter connection the practice of the division of fees under any guise whatsoever shall be prohibited.

3. There shall be a system of accurate and complete records filed in an accessible manner such records to include particularly a report of injury or illness, description of physical findings, treatment

estimated period of disability and results, as well as other information pertinent to the case or required by statute for Workmen's Compensation claims or other purposes.

4. Patients requiring hospitalization shall be sent to institutions approved by the American College of Surgeons.

5. The medical department or service shall have general supervision over the sanitation of the plant and the health of all employees.

The personnel of our Board on Industrial Medicine and Traumatic Surgery is as follows:

Frederic A. Beasley, Waukegan, Chairman
Bowman C. Crowell, Chicago, Secretary
John E. Bacon, Miami, Arizona
Bruce D. Campbell, Detroit
Frederic J. Cotton, Boston
Samuel R. Cunningham, Oklahoma City
George H. Gehrmann, Wilmington
Donald Guthrie, Sayre
Philip H. Kreuscher, Chicago
A. D. Laxenby, Baltimore
Carey P. McCord, Cincinnati
John R. Nilsson, Omaha
Thomas G. Orr, Kansas City
W. O'Neill Sherman, Pittsburgh
Loyal A. Shoudy, Bethlehem
Ernst A. Sommer, Portland, Oregon
George W. Swift, Seattle
Frederick J. Tees, Montreal
John B. Walker, New York
S. Marx White, Minneapolis

LIST OF APPROVED MEDICAL SERVICES IN INDUSTRY

The second list of approved medical services in industry follows. This approval is granted on the basis of compliance with the Minimum Standard for Medical Service in Industry as formulated by the American College of Surgeons. There are other industrial establishments whose medical services meet the requirements of this Minimum Standard but of which time has not yet permitted a survey. The asterisk (*) indicates Provisional Approval or that the medical services so designated have accepted the minimum requirements of the College standard and are endeavoring to carry them out but for lack of time or other acceptable reasons have not been able to do so in every detail.

ALABAMA

BIRMINGHAM

Alabama Power Company
American Cast Iron Pipe Co.
*Stockham Pipe & Fittings Company
Tennessee Coal, Iron and Railroad Company

GADSDEN

Goodyear Tire & Rubber Co. of Alabama
Gulf States Steel Company

MONTGOMERY

Alabama Dry Dock and Shipbuilding Co.
Southern Kraft Corporation
*Todd Shipbuilding & Dry Dock Co., Inc.

*Provisionally approved

WOODWARD

Woodward Iron Company

ARIZONA

INSPIRATION

Inspiration Consolidated Copper Company

MIAMI

Miami Copper Company

CALIFORNIA

CROCKETT

California and Hawaiian Sugar Refining Corporation, Limited

CULVER CITY

*Metro-Goldwyn-Mayer Corporation

EMERYVILLE

Paraffine Companies, Inc. The

LONG BEACH

*Ford Motor Company

LOS ANGELES

Firestone Tire & Rubber Company of California
*Fox Film Corporation
General Petroleum Corporation of California
Goodyear Tire & Rubber Company of California
Pacific Electric Railway Company
Pacific Goodrich Rubber Company
Paramount Productions, Inc.
R.K.O. Studios, Inc.
Southern Pacific Company
Standard Oil Company of California
*United Artists Studio Corp. Ltd.

OAKLAND

Fisher Body Oakland Division, General Motors Corporation
 *Montgomery Ward & Co.

SAN BERNARDINO

Atchison, Topeka and Santa Fe Railway System, The

SAN FRANCISCO

*Exportum, The
 Market Street Railway Company
 Pacific Telephone and Telegraph Company The
 Southern Pacific Company
 Standard Oil Company of California

SANTA MONICA

Douglas Aircraft Company Inc.

UNIVERSAL CITY

*Universal Pictures Corporation

COLORADO

DENVER

Colorado & Southern Railway Company, The
 Denver and Rio Grande Western Railroad Company The
 Denver Tramway Company The
 Ford Motor Company
 Gates Rubber Co
 Public Service Company of Colorado
 Union Pacific System

DENVER

Colorado Fuel & Iron Co The

CONNECTICUT

BRIDGEPORT

Bassick Company The
 Bridgeport Brass Company
 General Electric Company
 Remington Arms Company, Inc
 Sargent Manufacturing Co The
 Stanley Works, The
 American Tube & Stamping Plant

BRISTOL

New Departure Manufacturing Co The

HARTFORD

Colt & Patent Fire Arms Manufacturing Co
 Travelers Insurance Company The

NEW BRITAIN

Stanley Works, The

NEW HAVEN

*National Folding Box Company
 Sargent & Company
 Seamless Rubber Co The
 Winchester Repeating Arms Company

SOUTH MANCHESTER

Cheney Brothers

SOUTH NORWALK

*Flat Corporation of America

STAMFORD

Yale & Towne Manufacturing Company The

TROMBONVILLE

Reglow-Sanford Carpet Co Inc

WATERBURY

American Brass Company The
 Chase Companies, Incorporated
 Scovill Manufacturing Company

DELAWARE

WILMINGTON

duPont, E. I., de Nemours & Company

*Previously approved

DISTRICT OF COLUMBIA

WASHINGTON

*Capital Transit Company
 Chesapeake and Potomac Telephone Companies, The
 *Hecht Co., The
 *Kann, S. Sons Co.
 *Lambuth & Bro.
 Navy Yard
 *Potomac Electric Power Company
 Washington Gas Light Company
 *Woodward & Lothrop

FLORIDA

JACKSONVILLE

Ford Motor Company

TAMPA

*Dixie Packing Corporation

GEORGIA

ATLANTA

Chevrolet Motor Company
 *Exposition Cotton Mills

GALENSVILLE

Chickopee Manufacturing Corporation of Georgia

ILLINOIS

CHICAGO

Armour and Company
 Automatic Electric Company
 Chicago, Burlington & Quincy Railroad Company
 Chicago Rapid Transit Company
 Chicago, Rock Island & Pacific Railway Co The
 Commonwealth Edison Company
 Crane Co
 General Household Utilities Company
 Illinois Central Railroad Company
 Illinois Steel Company
 Interlake Iron Corporation
 International Harvester Company
 Pullman Standard Car Manufacturing Company
 Pullman, Incorporated
 Sears, Roebuck and Co
 Standard Oil Company (Indiana)
 Swift & Company
 Western Electric Company
 *Wilson & Co Inc.

MONTICELLO

Deere & Company

PEORIA

Caterpillar Tractor Co.

ROCKFORD

Ingersoll Milling Machine Company The

ROCK ISLAND

International Harvester Company
 Rock Island Sash & Door Works
 *Servus Rubber Co.

INDIANA

ANDERSON

Delco-Remy Division, General Motors Corporation

BUFFINGTON

Universal Atlas Cement Co.

CONCORDVILLE

Asburn Automobile Company

EAST CHICAGO

Youngstown Sheet and Tube Company The

FORT WAYNE

General Electric Company
International Harvester Company

GARY

Illinois Steel Company

INDIANA HARBOR

Inland Steel Company

INDIANAPOLIS

Lilly, Eli, and Company
Link Belt Company
National Malleable and Steel Castings Company
Prest-O-Lite Company, Inc. The
Real Silk Hosiery Mills, Inc.

MISHAWAKA

Mishawaka Rubber & Woolen Mfg. Co.

MUNCIE

Ball Brothers Company
Delco-Remy Division, General Motors Corporation
Warner Gear Company

SOUTH BEND

Studebaker Corporation, The

WHITING

Standard Oil Company (Indiana)

IOWA**BURLINGTON**

Chicago Burlington & Quincy Railroad Company

CEDAR RAPIDS

Quaker Oats Company
Sinclair T. M. & Co. Ltd.

DES MOINES

Iowa Packing Company
Northwestern Bell Telephone Company

FORT MADISON

Atchison, Topeka and Santa Fe Railway Company The

MASON CITY

Jacob E. Decker & Son

OTTUMWA

John Morrell & Co.

SIOUX CITY

Armour and Company
Cudahy Packing Company The
Swift & Company

KANSAS**KANSAS CITY**

Procter & Gamble Mfg. Company The
Wilson & Co. Inc.
*Swift & Company

NEWPORT

Newport Rolling Mill Company The

LOUISIANA**BOGALUSA**

Great Southern Lumber Company
Bogalusa Paper Company Inc.

NEW ORLEANS

American Sugar Refining Company The
Holmes, D. H. Company Limited
New Orleans Public Service, Inc.

MAINE**BIDDEFORD**

*Pepperell Mfg. Co.

Provisionally approved

BIDDEFORD (Continued)

Saco-Lowell Shops
*York Manufacturing Co.

CUMBERLAND MILLS

*S. D. Warren Co.

LEWISTON

Andruscoggin Mills
*Bates Mfg. Co.
Lewiston Bleachery and Dye Works

ROXFORD

Continental Paper and Bag Corporation
Oxford Paper Company

SANFORD

*Goodall Worsted Co.
Sanford Mills

WATERVILLE

Hollingsworth & Whitney Company

MARYLAND**BALTIMORE**

Abell, A. S. Company The
American Can Company
American Hammered Piston Ring Co. The
American Sugar Refining Company The
Baltimore and Ohio Railroad Company The
Baltimore Copper Smelting & Rolling Co.
Bartlett Hayward Co. The
Bethlehem Shipbuilding Corporation Ltd.
Chesapeake and Potomac Telephone Company of Baltimore City, The
Consolidated Gas Electric Light and Power Company of Baltimore

***Crosby & Blackwell**

Crown Cork & Seal Company Inc.

***Eastern Rolling Mill Company The**

Emerson Drug Company

Fairfield Western Maryland Dairy

***Hochschild Kohn & Co.**

Hutzel Brothers Co.

May Company The

Maryland Casualty Company

Montgomery Ward & Co.

National Enamelling and Stamping Company

Procter & Gamble Mfg. Company The

Revere Copper and Brass Incorporated

Schluderberg, The Wm.,—T. J. Kurdie Co.

Standard Oil Company of New Jersey

*Standard Wholesale Phosphate and Acid Works, Inc.

***Stewart & Co.**

*United Railways and Electric Company of Baltimore

The

Western Electric Company

Western Maryland Railway Company

SPARKS POINT

Bethlehem Steel Company

TOWSON

*Black & Decker Mfg. Co., The

MASSACHUSETTS**BEVERLY**

United Shoe Machinery Corporation

BOSTON

Boston Elevated Railway

Edison Electric Illuminating Company of Boston, The

Navy Yard

New England Telephone and Telegraph Company

United Fruit Company

CAMBRIDGE

- *Boston Woven Hose & Rubber Co
- *Lever Brothers Company

CHARLESTOWN

- Revere Sugar Refinery

CLINTON

- Wickwire Spencer Steel Company

EAST WALPOLE

- Bird & Son, Incorporated

EVERETT

- Colonial Beacon Oil Company Inc

FALL RIVER

- American Printing Company

FRAMMORUM

- Dennison Manufacturing Co

HOLYOKE

- American Writing Paper Company Incorporated
- Fair Alpaca Company
- National Blank Book Co
- William Slinger & Sons

LAWRENCE

- American Woolen Company
- Arlington Mills
- Pacific Mills

LEONARDT

- DuPont Viscoloid Company Incorporated

LOWELL

- Merrimack Manufacturing Company

MALDEN

- Con. ene Rubber Company

NEW BEDFORD

- *National Silk Spinning Company
- *Wamsutta Mills

NORTH PLYMOUTH

- Plymouth Cordage Company

PITTSFIELD

- *General Electric Company

QUINCY

- Bethlehem Shipbuilding Corporation Ltd.

SALEM

- *Nauvoo Steam Cotton Co

SOUTH BOSTON

- American Sugar Refining Company The

SOUTHBOROUGH

- American Optical Company

SPRINGFIELD

- Fiberland Corporation, The
- Ludlow Manufacturing Associates
- Moore Drop Forging Company
- Spaulding, A. O. & Bros
- United American Bosch Corporation
- Westinghouse Electric & Manufacturing Company

WALPOLE

- Lewis Mfg Co

WATERTOWN

- Hood Rubber Company Inc

WEST LYNN

- General Electric Company

WORCESTER

- American Steel & Wire Company
- Crompton & Knowles Loom Works
- Gruen & Knight Company
- Norton Company
- Whittall, M. J. Associates Ltd

*Previously approved

MICHIGAN

BAY CITY

- Chrysler Bay City Division General Motors Corporation

DEARBORN

- Ford Motor Company
- Highland Park Plant
- River Rouge Plant
- Lincoln Motor Car Company

DETROIT

- Detroit Edison Company The
- Dodge Brothers Corporation Division of Chrysler Corporation
- Fisher Body Detroit Division, General Motors Corporation
- Frederick Stearns & Company
- Hudson, The J. L., Company
- *Kelley Hayes Wheel Company
- Kelvinator Corporation
- Michigan Bell Telephone Company
- Packard Motor Car Company
- Parks, Davis & Company
- *Trunk-Detroit Axle Company The
- United States Tire Company

ECONSE

- Great Lakes Steel Corporation

FLINT

- A. C. Spark Plug Company Division General Motors Corporation

GRAND RAPIDS

- American Seating Company

LA SMO

- Olds Motor Works, Division General Motors Corporation
- *Reo Motor Car Company

PARCHMENT

- *Kalamazoo Vegetable Parchment Co

SAGINAW

- *Saginaw Malleable Iron Division General Motors Corporation
- *Saginaw Steering Gear Division General Motors Corporation

MINNESOTA

DULUTH

- American Steel & Wire Company
- Universal Atlas Cement Co

MINNEAPOLIS

- Minneapolis-Moline Power Implement Company
- Northwestern Bell Telephone Company
- Pillsbury Flour Mills Company
- *Sears, Roebuck and Co
- Washburn Crosby Co Inc

ST. PAUL

- Great Northern Railway Company
- Montgomery Ward & Co
- Northern Pacific Railway Company
- *Waldorf Paper Products Company

SOUTH ST. PAUL

- Armour and Company
- *Swift & Company

MISSOURI

KANSAS CITY

- Kansas City Power & Light Company
- Loose Wiles Biscuit Company
- Sears, Roebuck and Co
- Southwestern Bell Telephone Company

ST LOUIS

Anheuser Busch Inc.
 *Century Electric Company
 Chevrolet Motor Company of St. Louis
 Famous-Barr Company, May Department Stores Co
 Fisher Body St. Louis Division, General Motors Corporation
 Ford Motor Company
 International Shoe Co
 Mallinckrodt Chemical Works
 Monsanto Chemical Works
 Southwestern Bell Telephone Company
 Stix, Baer and Fuller Company
 Union Electric Light and Power Company

NEBRASKA

OMAHA

Union Pacific System

SOUTH OMAHA

Armour and Company
 Swift & Company

NEW HAMPSHIRE

DOVER

Pacific Mills, Cochecho Division

MANCHESTER

International Shoe Co

NEW JERSEY

ARLINGTON

DuPont Viscoloid Company

BAYONNE

Standard Oil Company of New Jersey

BATWAY

Standard Oil Company of New Jersey

CAMDEN

Campbell Soup Company
 Evans, John R., & Company
 R C A Manufacturing Company Inc.

ELIZABETH

Singer Manufacturing Co The

HOBOKEN

United Dry Docks, Incorporated

JERSEY CITY

Standard Oil Company of New Jersey

KEARNY

Western Electric Company

NEWARK

Bamberger L., & Co
 Clark Thread Company The
 New Jersey Bell Telephone Company
 Prudential Insurance Company of America, The

PAULSBORO

Socoay Vacuum Oil Company Incorporated

PEWEE GROVE

duPont, E. I. de Nemours & Company
 Dye Works

PEWEE ARROY

*Raritan Copper Works

ROSELING

John A. Roebling's Sons Company

TRENTON

John A. Roebling's Sons Company

Provisionally approved.

NEW YORK

ALBANY

A. P. W. Paper Co
 Huyck, F. C. & Sons, Kenwood Mills
 New York Power and Light Corporation

AMSTERDAM

Bigelow-Sanford Carpet Co., Inc
 Mohawk Carpet Mills

AUBURN

International Harvester Company

BINGHAMTON

Agfa Ansco Corporation

BROOKLYN

Brooklyn-Manhattan Transit System
 New York Telephone Company
 Sperry Gyroscope Company Inc.
 Squibb E. R., & Sons
 United Dry Docks, Incorporated

BUFFALO

American Brass Company The
 Buffalo Forge Company
 Chevrolet Motor Company of Buffalo
 Dold, Jacob Packing Co
 Dunlop Tire and Rubber Company
 DuPont Rayon Company Inc.
 Fisher Body Company Division General Motors Corporation

Ford Motor Company

Larkin Co., Inc.

New York Telephone Company

Pierce-Arrow Motor Car Company The

Pillsbury Flour Mills Company

Republic Steel Corporation

Washburn Crosby Company Inc

Worthington Pump and Machinery Corporation

CORNING

Corning Glass Works

CORTLAND

*Wickwire Brothers

ELMIRA

Willys-Morrow Company

ENDICOTT

Endicott Johnson Corporation
 International Business Machines Corporation

JAMESTOWN

Art Metal Construction Company

LACKAWANNA

Bethlehem Steel Company

LONG ISLAND CITY

National Sugar Refining Co of New Jersey The

MADISON HARBOR, S. I.

Procter & Gamble Mfg. Company The

NEW YORK

American Telephone and Telegraph Company
 *Bankers Trust Company
 Bell Telephone Laboratories
 Consolidated Gas Company of New York, and Affiliated Companies
 Employers Liability Assurance Corp. Ltd., The
 Federal Reserve Bank of New York
 Gimbel Brothers
 Horn & Hardart Company, The
 Interborough Rapid Transit Company
 International Paper Company
 International Telephone & Telegraph Corporation
 Macy R. H. & Co. Inc.

SWINVALE

Union Switch & Signal Company

VANDERGRIFT

American Street & Tin Plate Co

WILKES-BARRE

Lehigh Valley Coal Company The

WILLIAMSPORT

Lycoming Manufacturing Company

WILKESBORO

Westinghouse Air Brake Company

YORK

York Ice Machinery Corporation

RHODE ISLAND**PAWTUCKET**

Costa, J. & P. (R. I.) Inc

Lorraine Manufacturing Company

PROVIDENCE

Brown & Sharpe Mfg. Company

Builders Iron Foundry

Dartol Rubber Company

Gorham Manufacturing Company

National India Rubber Company

U. S. Finishing Company The

Wanlock Mills

SAYLESVILLE

Sayles Finishing Plants, Inc

TEXAS**BAYTOWN**

Humble Oil & Refining Company

DALLAS

Ford Motor Company

FOUR WORTS

Armour and Company

Swift & Company

HOUSTON

Houston Lighting & Power Company

Humble Oil & Refining Company

Sinclair Refining Company

Southern Pacific Lines in Texas and Louisiana

UTAH**SALT LAKE CITY**

American Smelting & Refining Co

U. S. Smelting, Refining and Mining Co

Utah Copper Company

VERMONT**RUTLAND**

Rutland Railroad Company

ST. JOHNSBURY

Fairbanks, E. and T. and Company

WINDSOR

American Woolen Company Champlain Mills

VIRGINIA**DAWVILLE**

Riverside & Dan River Cotton Mills

NEWPORT NEWS

Newport News Shipbuilding and Dry Dock Company

NOFOLK

Ford Motor Company

PORTSMOUTH

Norfolk Navy Yard

Previously approved

RICHMOND

American Suppliers, Inc

American Tobacco Company The

Richmond Branch

Virginia Branch

DuPont Cellophane Company Inc.

DuPont Rayon Company Inc

*Virginia Electric and Power Company

ROANOKE

Norfolk and Western Railway Company

*Viscose Corporation of Virginia, The

WASHINGTON**SEATTLE**

Ford Motor Company

Frederick & Nelson

WEST VIRGINIA**BELLE**

DuPont, E. I. de Nemours & Company

BLUEFIELD

Norfolk and Western Railway Company

CHARLESTON

Libbey-Owens-Ford Glass Company

CLARKSBURG

Weston Steel Company

GARY

United States Coal & Coke Company

HENTONSTON

Chesapeake and Ohio Railway Company The

International Nickel Company Inc., The

MARTINSBURG

Interwoven Mills, Inc

PARKERSBURG

Viscose Company The

SOUTH CHARLESTON

Carbide and Carbon Chemicals Corporation

WEIRTON

Weirton Steel Company

WILLIAMSBURG

Norfolk and Western Railway Company

WISCONSIN**BELLOTT**

Fairbanks, Morse & Co

CUDAHY

Cudahy Brothers Company

KOHLER

Kohler Co

MILWAUKEE

Bacynus-Erie Company

Cutler Hammer Inc.

Globe Union Mfg. Company

International Harvester Company

*Plankinton Packing Co

Sunk, A. O. Corporation

RACINE

J. I. Case Company

CANADA**ONTARIO****NIAGARA FALLS**

American Cyanamid Company

THE 1934 HOSPITAL STANDARDIZATION SURVEY

MALCOLM T. MACEACHERN, M.D., CHICAGO, ILLINOIS

Associate Director, American College of Surgeons

DURING the past year 3,539 hospitals were registered with the American College of Surgeons for survey. Of this number 2,483 were Fully and Provisionally Approved, thus attaining 70 per cent of all hospitals of 25 beds and over on the Approved List.

Special mention should be made of the excellent services rendered in the field survey by E. W. Williamson, M.D., Assistant Director of Hospital Activities, and Field Representatives T. R. Ponton, M.D., and F. C. Bell, M.D., men thoroughly experienced in all aspects of hospital work, who assisted hospitals in the solution of many of their problems at the time of the survey. Their detailed carefully compiled reports made a valuable addition to the fund of information which the College has on file from surveys made during the past 17 years.

The survey revealed evidence that despite economic conditions hospitals are maintaining high standards in the professional care of the patient. While continued reductions in budgets and reduction in personnel have been necessary in many instances, the morale of the hospitals generally has been splendidly maintained. Personal interests have been willingly subordinated for the benefit of the patient, and every effort has been put forth to adhere to the requirements which assure the most efficient care of the patient.

The following is an analysis of the results of the survey:

1. Hospitals of 100 beds and over

Surveyed	1649
Fully approved	1484
Percentage fully approved	90.0
Provisionally approved	77
Percentage provisionally approved	4.7
Not approved	88
Percentage not approved	5.3
Total fully and provisionally approved	1561
Total percentage approved	94.6

2. Hospitals of 50 to 99 beds

Surveyed	1051
Fully approved	505
Percentage fully approved	53.8
Provisionally approved	129
Percentage provisionally approved	12.2

Not approved	357
Percentage not approved	34.0
Total fully and provisionally approved	694
Total percentage approved	66.0

3. Hospitals of 25 to 49 beds

Surveyed	839
Fully approved	169
Percentage fully approved	20.0
Provisionally approved	59
Percentage provisionally approved	7.0
Not approved	611
Percentage not approved	73.0
Total fully and provisionally approved	228
Total percentage approved	27.2

4. Government Hospitals

(a) Army	
Surveyed	5
Fully approved	5
Percentage fully approved	100.0

(b) Navy	
Surveyed	15
Fully approved	15
Percentage fully approved	100.0

(c) Public Health Service	
Surveyed	25
Fully approved	25
Percentage fully approved	100.0

(d) Veterans Bureau	
Surveyed	73
Fully approved	73
Percentage fully approved	100.0

5. Other Countries

Thirty-one hospitals of other countries have been awarded full approval, and are included in the List of Approved Hospitals for 1934.

Summary

Total surveyed	3539
Total fully approved	2218
Total percentage fully approved	62.6
Total provisionally approved	265
Total percentage provisionally approved	7.4
Total not approved	1056
Total percentage not approved	30.0
Total fully and provisionally approved	2483
Total percentage approved	94.6
Hospitals 100 beds and over	24.6
Hospitals 50 beds and over	83.5
Hospitals 25 beds and over	70.0

SWITZERLAND

Union Switch & Signal Company

VANMETER

American Sheet & Tin Plate Co

WILKES-BARRE

Lehigh Valley Coal Company The

WILLIAMSPORT

Lycoming Manufacturing Company

WILMINGTON

Westinghouse Air Brake Company

YORK

York Ice Machinery Corporation

RHODE ISLAND

PAWTUCKET

Costa, J & P (R. I.) Inc

Lorraine Manufacturing Company

PROVIDENCE

Brown & Sharpe Mfg. Company

Builders Iron Foundry

Daval Rubber Company

Gotham Manufacturing Company

National India Rubber Company

U. S. Finishing Company The

Wanskuck Mills

SAYLEYSVILLE

Sayles Finishing Plants, Inc

TEXAS

BAYTOWN

Humble Oil & Refining Company

DALLAS

*Ford Motor Company

FORT WORTH

Armour and Company

Swift & Company

HOUSTON

Houston Lighting & Power Company

Humble Oil & Refining Company

Sulclair Refining Company

Southern Pacific Lines in Texas and Louisiana

UTAH

SALT LAKE CITY

American Smelting & Refining Co

U. S. Smelting, Refining and Mining Co

Utah Copper Company

VERMONT

RUTLAND

Rutland Railroad Company

ST. JOHNSBURY

Fairbanks, E. and T. and Company

WINDSOR

American Woolen Company Champlain Mills

VIRGINIA

DANVILLE

Riverdale & Dan River Cotton Mills

NEWPORT NEWS

Newport News Shipbuilding and Dry Dock Company

NOFOLK

Ford Motor Company

PORTSMOUTH

Norfolk Navy Yard

*Previously approved

RICHMOND

American Suppliers, Inc.

American Tobacco Company The

Richmond Branch

Virginia Branch

DuPont Cellophane Company Inc

DuPont Rayon Company Inc

*Virginia Electric and Power Company

ROANOKE

Norfolk and Western Railway Company

*Viscos Corporation of Virginia, The

WASHINGTON

SEATTLE

Ford Motor Company

Frederick & Nelson

WEST VIRGINIA

BELL

*DuPont, E. I. de Nemours & Company

BLUFFTON

Norfolk and Western Railway Company

CHARLESTON

Libbey-Owens-Ford Glass Company

CLARKSBURG

Weirton Steel Company

GARY

United States Coal & Coke Company

HUNTINGTON

Chesapeake and Ohio Railway Company The

International Nickel Company Inc The

MARTINSBURG

*Interwoven Mills, Inc

PARKERSBURG

Viscos Company The

SOUTH CHARLESTON

Carbide and Carbon Chemicals Corporation

WEIRTON

Weirton Steel Company

WILLIAMSON

*Norfolk and Western Railway Company

WISCONSIN

BELLOTT

Fairbanks, Morse & Co

CUDAHY

Cudahy Brothers Company

KOBLER

Kobler Co

MILWAUKEE

*Bacynus-Erie Company

Cutter Hammer Inc.

Globe Union Mfg. Company

International Harvester Company

Plankinton Packing Co

Smith, A. O. Corporation

RACINE

J. I. Case, Company

CANADA

ONTARIO

NIAGARA FALLS

American Cyanamid Company

- COLSON COMPANY** Elyria, Ohio
Colson invalid chair and accessories.
Colson wheel chair
Colson safety inhalator
- COLUMBIAN ENAMELING & STAMPING COMPANY** Terre Haute, Ind.
Columbian-made enameled ware for hospital use
COMPLEX OSCILLATOR CORPORATION New York.
McCarthy surgical unit.
- CONGOLITHUM NAIM** Kearny N J
Cork composition sealer linoleum flooring products.
- CRANE COMPANY** Chicago
Hospital plumbing fixtures for hospital use
- DORRILL METAL FURNITURE COMPANY INC** New York, N Y
Metal furniture and hospital equipment
- DUKE LABORATORIES, INC.,** Long Island City N Y
Elastoplast.
- EASTMAN KODAK COMPANY** Rochester N Y
Clinical camera.
Dark room safelights
Dental X ray film.
X ray developing hangers
X-ray films.
X ray illuminators.
X ray intensifying screens.
- ELECTRIC STORAGE BATTERY COMPANY** Philadelphia.
Eldco emergency lighting battery system.
- E. H. ERICKSON ARTIFICIAL LIMB COMPANY** Minneapolis, Minn.
Artificial limbs.
- FORGGER COMPANY** New York.
Flagg resuscitation apparatus.
Goedel oxygen meter and tent outfit
Henderson infant resuscitation outfit
Metric gas machine.
- FRIGIDAIRE CORPORATION** Dayton, Ohio
Frigidaire
- GENERAL ELECTRIC COMPANY** Incandescent Lamp Dept
Cleveland, Ohio
 Mazda sunlight lamps, types S-1 and S-2
- GENERAL ELECTRIC CORPORATION** Schenectady N Y
Refrigerator
- GENERAL ELECTRIC X RAY CORPORATION** Chicago
Quartz lamp series.
Shock proof X ray apparatus, models A and B
- GRUNOW CORPORATION** Chicago
Refrigerator
- FRANK A. HALL & SONS**, New York.
Hospital beds.
- HAKOVIA CHEMICAL & MANUFACTURING COMPANY**, New ark, N J
Super Alpine sun lamp
Luxor model, Alpine sun lamp.
Group-Irradiation super Alpine sun lamp
Super self-contained Kromayer mercury-arc lamp.
- HEIDRICK COMPANY** Minneapolis, Minn.
Lundy gas-oxygen apparatus
- JOHN-MANVILLE SALES CORPORATION** New York.
Asbestos waterproofing built-up roofing J M asbestos rigid shingles J M asphalt tile flooring J M home insulation J M system of sound isolation Naahkote acoustical treatments, Rockoustille: Sanaacoustic holo-rib panels, the Transite asbestos sheets, Transite acoustical tile.
- JOHNSON & JOHNSON** New Brunswick, N J
Absorbent cellulose absorbent cotton, rolls and balls absorbent gauze, adhesive plaster bandage rolls, Bellevue surgical wadding cellulose wipes nose and mouth masks operating room cape; orthoplast—
- plaster-of-paris bandages specialist plaster-of-paris bandages standard surgical dressings surgical crino-line.
- H. L. JUDD COMPANY** New York N Y
Day's Curtain Screening Equipment.
- E. H. KAHRER COMPANY** Milwaukee, Wis.
Lemon's improved portable traction apparatus
- HENRY L. KAUFMAN & COMPANY** Boston
Norlike rubber sheets.
- KELLEY ROBERT MANUFACTURING COMPANY** Covington Ky
Keleket plate changers
Keleket tables
Keleket transformers in excess of 150 P. K. V
Keleket X ray accessories.
Keleket X ray transformers of voltages inclusive of 150 P. K. V
Miscellaneous Keleket equipment.
- Kewaunee Manufacturing Company** Kewaunee, Wis.
Biology and bacteriology table No. C 350.
Chemical proof sink No. F 1195
Chemical work table No. H 1532
Clinical laboratory table Nos. E 1079 E-1081 E 1083
Dietetic table Nos. K 1825 K 1830
Dissecting table Nos. E 1073 E-1078
Double sink No. K 1852A.
Instrument and display case No. G-1376
Laboratory truck No. F 1173.
Laboratory wall sink No. F 1181
Microscopic and display case No. G-1333
Organic chemistry table No. D-857
Physiological chemistry table No. E-1099
Private laboratory desk No. H 1524.
Qualitative analysis table No. D-816
Sink No. K 1879
Skeleton case No. G-1347
Sliding sash fume hood No. D-974.
Trapezoidal microscopic table No. C 354.
KO-RAY MANUFACTURING COMPANY Chicago.
Ko-Ray cooker
- LESTER, WHITMAN & COMPANY** New York
Lester mohairs
- LEWIS MANUFACTURING COMPANY** Walpole Mass.
A. B. D. pads and rolls absorbent cotton adhesive plaster bandage rolls cellulocotton absorbent wadding in rolls cellulocotton combination pads cellulowipers combination dressing rolls combination pads combination rolls crinolines for plaster bandages dressing rolls gauze in bolts, moleskin adhesive plaster non-absorbent cotton Noravel bandages O B pads orthopedic stockinette plaster bandages, ready-cut cellulocotton absorbent wadding ready-cut gauze salvage gauze sheet wadding surgical sponges.
- MARKET FRODO COMPANY** Everett, Mass.
Maforco autopsy tables
Maforco food veyors
Maforco mortuary racks.
Maforco refrigerator racks.
- MASSELLON RUBBER COMPANY** Massillon, Ohio
Matex Anode surgical gloves.
- MEDICAL BELT COMPANY** New York, N Y
Medial maternity garments Nos. 6001-6001
Medial postoperative supports Nos. 6012-6012 6043-6053
Medial pendulous abdominal supports Nos. 6017-6047
Medial ptosis supports Nos. 6015-6025
Medial micro-linc support No. 6016.
Medial hernia and kidney support No. 6058
Medial maternity brassiere No. 3005.
Medial nursing brassiere No. 3001
Medial brassiere Nos. 3008 and 3018.

- NATIONAL CARBON COMPANY** Cleveland
Eveready professional model carbon arc lamp
Eveready solenium type carbon arc lamp
NOVOC COMPANY Lowell, Mass
Vic crepe bandage
- PATTERSON SCREEN COMPANY** Towanda, Pa
Fluoroscopic X-ray screens
Foreign body X-ray fluoroscope
Intensifying X-ray screens
Operating X-ray fluoroscope
- PYAD'S AMERICAN INSTRUMENT COMPANY**, New York
Anatomical specimens for ear, nose and throat
Surgical instruments for ear, nose and throat work
- SAFETY ANESTHESIA APPARATUS COMPANY**, Chicago
Safety gas-oxygen apparatus, McCurdy models A and B
Safety gas-oxygen apparatus, models F and D
- SAMBORN COMPANY** Cambridge, Mass
Motor-Grafc metabolism tester
- F. O. SCHROEDER**, Columbus, Ohio
Ohio operating table No. 2
Visible clinical chart desks and portable chart racks
Elevating wheel stretcher
Combination bedside and overbed tables
Adjustable overbed tables, crank operated
Delivery tables CA 2500 and CA 2500-A
- SCIENTIFIC CORPORATION OF AMERICA**, Philadelphia
Shadowless operating light
- SPIRY & LLOYD**, Milford, Ohio
Semi-swab cotton wound applicator
- STURMAN RUBBER FLOORING COMPANY** South Braintree, Mass
Reinforced rubber accessories—ash trays, bed bumpers, drain mats, molded tops, vase plates, vases
- Reinforced rubber tile
- STICKLEY BROTHERS COMPANY** Grand Rapids, Mich
Hospital furniture
- STILLE SCARLAN COMPANY** New York
Surgical instruments of stainless steel
- TROY LAUNDRY MACHINERY COMPANY** Chicago
Laundry machinery for hospital use
- UTICA & MICHIGAN COTTON MILLS**, Utica, N. Y.
Heavy duty muslin sheets
- VERBAL CHEMICAL LABORATORIES**, St. Louis
Infantol dispenser
Septisol dispenser
- WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY**, Mansfield, Ohio
Refrigerator
- WESTINGHOUSE X-RAY COMPANY** Long Island City, N. Y.
Endotherm
- WILMOT CASTLE COMPANY** Rochester, N. Y.
Castle lights Nos. 10, 15, 20, 30, and 40, autoclave, pressure water sterilizers, instrument sterilizers, uterine sterilizers, stills, bedpan and urinal sterilizers, blanket warmers, solution warmers, sterilizers for utility rooms and clinics, bulk sterilizers and disinfectors, bacteriological apparatus
- WILSON RUBBER COMPANY** Canton, Ohio
Surgeons' gloves
- THE MAX WOODRIDGE & SON COMPANY** Cincinnati, Ohio
Moist R. Reid major operating table
- CARL ZEISS, INC.** New York
Pantophos operating room lamp, models A and B
- ZIMMER MANUFACTURING COMPANY** Warsaw, Ind.
Fracture bed and overhead frame

MEDICAL MOTION PICTURE FILMS

J BENTLEY SQUIER, M.D., F.A.C.S. NEW YORK, NEW YORK, Chairman

THE importance of motion pictures as a means of disseminating medical knowledge has been generally accepted by the profession and there is an ever increasing interest in the work of the American College of Surgeons in co-operation with the Motion Picture Producers and Distributors of America, Inc. Films produced under this arrangement are of unusual significance as examples of the possibilities of this method as an aid in the teaching of medicine and surgery.

The College is very glad to receive medical motion picture films for review. Many have already been sent in and a card catalog is being compiled as the films are reviewed with the idea of securing detailed data concerning all available medical and surgical films. This will enable us to supply information as to what films are available on any special subject, where they can be obtained, and whether or not they are satisfactory for the purpose desired.

During the past several years improvements have been made in recording methods and in projection equipment that will be important factors in the application of talking films to the teaching of medicine and surgery. The Board on Medical Motion Picture Films is keenly interested in the development of this type of films and is maintaining close contact with the various organizations concerned with this phase of motion picture production and distribution.

Very large audiences were present at all times at the continuous daily exhibition of medical motion pictures during the 1934 Clinical Congress. The 98 films used for these demonstrations included several new talking films with both sound-on film and disc recording and also colored motion picture films.

One hundred and twenty reels of medical motion picture films have been approved by the American College of Surgeons and are available for distribution. Many additional films have been reviewed by the College, and though they have not yet been formally approved, our reviewing committees consider them to be an effective presentation of the subject matter, and the procedures shown to be of interest and value.

Information pertaining to medical motion picture films may be obtained by communicating with the College.

The Board on Medical Motion Picture Films of the College consists of the following members:

Will H. Hays, Esq. New York, Honorary President
J. Bentley Squier, New York, Chairman
Philemon E. Truesdale, Fall River, Secretary
W. W. Chipman, Montreal
George Crile, Cleveland
Bowman C. Crowell, Chicago
Malcolm T. MacEachern, Chicago
Franklin H. Martin, Chicago
Charles H. Mayo, Rochester

STATE AND PROVINCIAL SECTIONAL MEETINGS

DURING the year 1934 five large and most successful sectional meetings were held as follows

Oklahoma, Texas, Arkansas, Kansas, Missouri—Oklahoma City February 22-23
Utah, Colorado, Idaho, Wyoming—Salt Lake City February 28 March 1
Washington, Oregon, Montana, British Columbia—Spokane, March 6-7
California, Nevada—Los Angeles, March 13-14
Arizona, New Mexico—Phoenix, March 15-16.

These meetings embraced 16 states and 1 province. The following Fellows of the College and others constituted the visiting speakers

Irvin Abell, Louisville; Alfred W. Adson, Rochester; Frederic A. Beasley, Waukegan; Thomas E. Carmody, Denver; Edward H. Cary, Dallas; George Crile, Cleveland; Frank D. Dickson, Kansas City; Charles A. Dukes, Oakland; Robert B. Greenough, Boston; Robert Jolly, Houston; Edward Jackson, Denver; Thomas M. Joyce, Portland; Allen B. Kanavel, Chicago; Philip H. Krenscher, Chicago; Malcolm T. MacEachern, Chicago; Franklin H. Martin, Chicago; Howard C. Naffziger, San Francisco; Gordon B. New, Rochester; Rev. A. M. Schuitalla, St. Louis.

Most thorough and complete arrangements were made in advance according to a well worked out and tried plan. This assured the success in carrying out every detail of the various phases of the two day meetings.

A carefully thought out and well arranged program consisting of 7 phases was prepared and executed at each meeting. This was as follows

a Clinics. The local Fellows of the College, with their associates or assistants and others, conducted daily clinics from 8:30 a. m. to 12:00 noon in the approved hospitals of the city in which the meeting was being held. These were in the main operative clinics but were sometimes supplemented by dry clinics showing end-results in certain types of surgical cases. There were also pathological and X ray demonstrations. In all 5 meetings more than 200 operative clinics were held. These were of special interest and were well attended.

b Scientific Sessions. Two major scientific sessions were held at each meeting: one on the evening of the first day and the other on the afternoon of the second day. The papers at these sessions were presented by the visiting speakers and Fellows of the College from the different states in the group represented. These sessions were of special interest not only to Fellows of the College but to the medical profession at large, who were invited to attend. The average attendance at these sessions ranged from 800 to 1,000. At the same time as the scientific sessions for general surgery, the eye, ear, nose and throat

section held their special sessions, which too were largely attended and were of intense interest.

c Medical Motion Pictures. A successful innovation this year was the showing of carefully selected medical motion pictures from 12:30 noon to 2:30 p. m. daily. These sessions were of particular interest. The audiences ranged from 200 to 1,800, with an average of 900 to 1,000 despite the fact that the sessions were held at the luncheon hour. These demonstrations proved that there is a distinct place for medical motion pictures on the program of these meetings, provided a very careful selection of pictures is made.

d Hospital Conference. Throughout the 3 days at each meeting a hospital conference was held, consisting of papers, round table discussions and demonstrations dealing with administrative, medical, economic and other problems. An extensive opportunity was afforded at these meetings for round table discussions and practical demonstrations in all phases of hospital administration and standardization, thus proving beneficial to all present. The average attendance at these sessions was 150 to 200, representing in each instance the majority of the hospitals in the states included in each group.

e Programs of Public Education. During the sectional meeting an extensive and effective program of public education, as to health, scientific medicine, and hospitals, was carried on in each community where the meeting was being held. This program consisted of informative press articles, appropriate talks before community service clubs, men's and women's organizations, high school and junior college students, and radio broadcasts by the visiting speakers. Finally this program culminated in a large Community Health Meeting as the closing session on the evening of the second or last day. To this meeting the lay public was invited. A program of brief, interesting, and instructive talks on topics of vital interest, given by outstanding speakers, was well received. These talks were in understandable language and were illustrated in most part. Through careful working up of interest in each community the audiences were so large that during the series 5 overflow meetings had to be arranged. The attendance at the meetings averaged 2,000 to 25,000, an aggregate of approximately 40,000, not including several thousand in Oklahoma City, Salt Lake City and Spokane, who had to be turned away.

f Annual Meeting. At each sectional meeting, the annual meeting of the Fellows of each state was held for the purpose of electing the various state officers for the ensuing year and for the discussion of College activities.

g Credentials Committee Meetings. At each sectional meeting such state credentials committee meetings were held as were considered feasible.

THE CREDENTIALS COMMITTEES AND COMMITTEE ON HISTORY REVIEWS

THE procedure of admitting candidates to Fellowship in the American College of Surgeons requires that each candidate after filing his application be recommended by his State or Provincial Credentials Committee before proceeding further with his papers. In each State and Province there is a Credentials Committee composed of from 15 to 35 members who are Fellows of the College, elected to serve on the Committee by the Fellows of the College of their respective State or Province for a term of 2 years, one-half of the Committee being retired each year.

No candidate is admitted to Fellowship without the recommendation of his State or Provincial Credentials Committee.

The members of these committees give generously of their time and meet at a designated city in their State or Province at least once a year to review the credentials of all candidates whose applications are on file from their respective State or Province. Much credit is due these committees for their part in the work of the selection of the men who comprise our Fellowship.

After a candidate for Fellowship has been recommended by the Credentials Committee of his State or Province, he is required to submit 100 clinical records to the College, 50 in complete detail of major work done by himself and for which he is the responsible surgeon and 50 in abstract of major work at which he has assisted or which he has done himself. These records are carefully examined by the Committee on History Reviews composed of outstanding surgeons in the fields of the surgical specialties from the 4 leading medical universities in Chicago.

This year 636 sets of histories were received and of that number 594 sets or 59,400 individual histories were examined in detail by the Committee on History Reviews. The remaining 32 sets were not reviewed as the applicants had not yet received the approval of their State or Provincial Credentials

Committee. Of those reviewed 539 sets were accepted and 55 sets were not accepted. Those whose histories were not accepted have the privilege of later submitting additional histories.

Sixteen meetings were held by the Committee on History Reviews for the purpose of studying histories and during the 4 weeks preceding the Clinical Congress many additional hours were spent by the members of this committee in order that every candidate's records received this year might be reviewed.

The records, half of which were histories of cases of major operations performed by the candidates and the other half abstracts of cases which they had operated upon themselves or at which they had assisted were checked with the utmost care particularly with respect to the pre-operative data indicating the thoroughness with which the case was studied, the technique and the end-results.

The histories which were recognized as being of unusual merit were segregated and were the subject of a special review of the committee as a whole for the selection of those which were considered from the standpoint of completeness, accuracy, and form of presentation to merit special mention.

The members of the Committee on History Reviews who have served this year and to whom the College is greatly indebted for the many hours spent in the laborious work of reviewing the histories submitted are

James H. Bloomfield
Dwight Freeman Clark
Harry Culver
William C. Danforth
Frank E. David
Géza de Takáts
Joseph S. Eisenstaedt
Oscar H. Kraft
Philip H. Krenscher
Francis L. Lederer

Michael L. Mason
Golder L. McWhorter
George J. Muirgrave
Thomas P. O'Connor
Rudolph J. E. Oden
Charles H. Parkes
Charles H. Philfer
Charles B. Puestow
Frederick W. Slobo
Guy S. Van Alstyne

THE LIBRARY AND DEPARTMENT OF LITERARY RESEARCH

THE Library and its allied Department of Literary Research have completed one more year of service to Fellows of the College and members of the medical profession.

The Library of the College was organized in 1931, and had as its nucleus the very splendid collection of volumes which had formed the library of the late Dr John B. Murphy. This collection has been augmented by the addition of such libraries as that of the late Dr Albert J. Ochsenr, a broad but well chosen and practical collection, fittingly presented by his heirs; the library of the late Dr William McDowell Meason of Mobile, Alabama, which includes eighteenth and nineteenth century volumes in French and English; back files of journals, as well as material having current reference value; and the very splendid collection of historical works and current monographs which Dr H. Winnett Orr of Lincoln, Nebraska is assembling.

In addition to the outstanding gifts above mentioned, Fellows and friends of the College have contributed many very valuable small collections and individual volumes, some consisting of treatises of historic interest and others of current reference works, especially valuable aids in the various pieces of research which are being carried on in the Department. Individual reprints and more extensive files have likewise been received.

In order that the Library may be truly representative of the work of every Fellow, that this great mass of valuable material may be preserved to posterity and that it may be available to any member of the profession who is studying similar or allied problems, every Fellow of the College is requested to contribute one copy of each of his monographs and two copies of his reprints (one for the Fellow file and one for circulation in the package library collection). Fellows are further urged to notify the Librarian of any collections which they themselves are in a position to present either now or at a later date, or which at their suggestion might be offered to the College—that these too may enter into a broader field of service and be made available to surgeons in New Zealand as well as to those in Chicago.

The availability of the Library is a factor dependent upon the services offered by the Department of Literary Research. The Department con-

sists of a small group of workers especially equipped to select reprints, compile bibliographies, and prepare abstracts and translations on medical and surgical subjects. If reprints only are desired these can be supplied without charge in package library form; bibliographies, abstracts and translations are furnished at a nominal fee.

During the past year many individual requests for research have been received, some of them being continuous surveys which have carried through the year and have required weekly or monthly reports, some pieces of research have required a series of abstracts or complete translations chosen from an extensive bibliography—others called for careful combing of all available sources for data on subjects upon which very little has been written.

Whatever the need of the individual Fellow—whether a review of the literature including extensive translations from the German, French, Italian, Spanish, Rumanian, or Scandinavian languages, or a simple bibliography compiled from the published indices—the staff is prepared to care for it efficiently. The Department has a high aim—to bring the literature of the world to the doorstep of every Fellow of the College whatever his need and wherever he may be located, and to do this expeditiously and economically.

PORTRAITS AND MEMORIALS IN THE LIBRARY

The Albert J. Ochsenr Memorial Room contains the collection of photographs assembled by the late Dr Ochsenr, founder, treasurer and past president of the College, as well as mementos of his life and work. Portraits of Dr and Mrs Elijah Dewey Harmon, physician and surgeon at Fort Dearborn in 1830, and a portrait of Mrs. Maud Mellish Wilson, who has done so much for the advancement of literary and editorial standards in medicine and surgery have recently been received. Mementos of historical significance—the mortar and pestle of the early physician and the medicine chest of the venturesome surgeon who accompanied the early French explorers along the Mississippi—these and other items of historical significance have been fittingly placed in the Library where it is hoped they will serve as an incentive for further gifts of a similar nature.

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HOSPITAL STANDARDIZATION

REPORT OF THE 1934 CONFERENCE IN BOSTON

AN abstract of the papers and discussions presented at the seventeenth annual Hospital Standardization Conference held in Boston, October 15-18, 1934, is found in the following pages. Dr. William D. Haggard, past president of the College, presided.

THE NEW DEAL IN HOSPITALS

WILLIAM D. HAGGARD, M.D. Nashville. The changing conditions in the economic structure make it incumbent upon the hospital to keep step with the progress of other forces in our social fabric. The prepayment plan of hospitalization, employed in many quarters, has the new principle of allowing people of very moderate means who cannot or will not budget their incomes to make provision for sickness. The insurance principle has through all of the depression been the one thing that has stood up; it is so strongly ingrained in American institutions that it deserves a fair trial in the hospitals.

The training school for nurses should receive a great deal of thought at this conference. There is an enormous surplus of nurses in this country and this is working a hardship because of severe unemployment conditions. The plan to utilize graduate nurses wherever possible with ward service maids commends itself for serious consideration. If fewer nurses could be graduated all could receive employment; the patients would not suffer and the hospitals would not lose thereby.

Hospitals must have more regard for the rights of the patients who are often on account of illness and fear, not in a position to fend for themselves as people do in health. The principle employed in the best hotels that "the guest is always right" should be a slogan in every hospital. *The patient is always right.*

The rôle of the hospital as a finishing year for graduates in medicine should ever be borne in mind. Ample living quarters with a working library and an increased number of autopsies should be provided. The best hospital attracts the best interne. Moreover, the type and efficiency of the interne are of incalculable benefit to the hospital.

The standardization program of the College has been an inspiration and a means of stabilization to all hospitals. Medicine and nursing have anticipated the policies of the New Deal. The embodiment of a definite code of ethics in business and industry is a wise and beneficent extension of the age-old ethics which have ever been practiced and cherished by both professions.

The United States and Canada contain the best and the largest number of hospitals of any country in the world. They have lived up to their opportunities, are making great progress, and will adapt themselves to the needs of our economic condition, whatever it may be. Trustees who have the responsibility, superintendents who have the leadership, directresses of nurses who inculcate the blessed art of nursing, the physicians and surgeons, who by example and precept, combine the tender solicitous heart with gentle and willing ministrations, will in the future as in the past, make our American hospitals the greatest institutions of our civilization.

SEVENTEENTH ANNUAL HOSPITAL STANDARDIZATION REPORT

FRANKLIN H. MARTIN, M.D. Chicago. The Hospital Standardization movement has proved to be of distinct benefit not only to the hospitals which have achieved approval but also to the patient, the physician, the interne, the nurse, and the community.

Hospital Standardization assures efficient care to the patient through better medical staff organization, competent personnel, and adequate diagnostic and therapeutic facilities. Further, the writing of medical records, the examination and study of pathological specimens, the regular review and analysis of the clinical work, and many other procedures of detail and precision assure a more accurate diagnosis and rational treatment for the patient. All this means speeding up treatment through shortening the days' stay in the hospital, reducing complications, and what is more important, lowering the mortality rate.

The approved hospital provides the physician with a proper environment in which to work. Not only has he the necessary facilities at his disposal, but also a well-trained staff to assist him. Through recording the history of his patient, through proper use of the diagnostic and therapeutic facilities, the staff conference, the clinicopathological conference, and other features made available in the approved hospital, the physician is not only able to give better care to his patient, but because of organized and systematized efforts he is constantly improving his armamentarium of scientific knowledge. Finally, his own professional status is improved, for he is known as an ethical practitioner who takes a definite stand against the splitting of fees.

The hospital finds it an advantage administratively, socially and economically to be approved

which makes for a more complete and efficiently functioning organization as a whole. The minimum standard provides the hospital with fundamental principles pertaining to the best plan for assuring good professional care to patients. The carrying out of the principles of the minimum standard gives better assurance that the administration is functioning in a manner to best fulfill its purpose.

Because of its organization, equipment, and personnel the approved hospital affords the interne and the nurse better supervised experience. To this end, it is now customary for young graduates of medicine and student nurses to seek information as to which hospitals are approved.

In most instances the community is directly or indirectly interested in its hospitals. The fact that they are living up to universally acknowledged and accepted standards of professional organization and service should give the community greater confidence and pride in such institutions. Indeed, many people requiring hospitalization today seek the approved hospital knowing that such an institution is organized so as to give adequate care and efficient service to the sick and injured.

Now I have the pleasure of presenting to you the annual Hospital Standardization report for 1934.

A SUMMARY OF REPORT—1918-1934

(1) Seventeen surveys of hospitals of 100 beds and over

1918—692 hospitals surveyed
89 hospitals fully and provisionally approved
12.9 percentage approved

1934—1,649 hospitals surveyed
1,560 hospitals fully and provisionally approved
94.6 percentage approved

(2) Thirteen surveys of hospitals 50 to 99 beds

1922—812 hospitals surveyed
335 hospitals fully and provisionally approved

41.3 percentage approved
1934—1,050 hospitals surveyed
692 hospitals fully and provisionally approved
65.9 percentage approved

(3) Eleven surveys of hospitals of 25 to 49 beds

1924—307 hospitals surveyed
49 hospitals fully and provisionally approved
15.9 percentage approved

1934—839 hospitals surveyed
228 hospitals fully and provisionally approved
27.2 percentage approved

(4) Ten surveys of Government hospitals of the United States

1925—100 hospitals surveyed
90 hospitals fully and provisionally approved
90.0 percentage approved

1934—118 hospitals surveyed
118 hospitals fully and provisionally approved
100 percentage approved

Total surveyed	3,538
Total fully approved	2,209
Total percentage fully approved	62.4
Total provisionally approved	271
Total percentage provisionally approved	7.6
Total not approved	1,058
Total percentage not approved	30.0
Total fully and provisionally approved	2,480
Total percentage fully and provisionally approved	70.0
Hospitals 100 beds and over	94.6
Hospitals 50 beds and over	83.4
Hospitals 25 beds and over	70.0

GUIDING FUNDAMENTAL PRINCIPLES FOR PREPAYMENT OF HOSPITAL AND MEDICAL SERVICE

CHARLES A. DUKES M.D. Oakland There are certain definite general principles to be followed in the organization of any periodic prepayment plan which are directed toward obviating the known difficulties and dangers threatening the success of special forms of medical and hospital service. The American College of Surgeons has stated these principles as follows:

"a. Periodic prepayment plans for medical service should be free from the intervention of commercial intermediary organizations operating for profit. After deduction of the clerical costs of operation of the fund and such accumulation of reserve as may be advisable in the interests of the contributors or may be legally imposed, the full amount paid by the contributors should be available for medical and hospital services.

"b. In the interests of the patient, the organization of plans for the periodic payment of medical and hospital costs must be under the control of the medical profession in co-operation with the hospitals, and such other allied services as may be involved in the individual project, together with a group of citizens representative of the whole community and of industry who are interested in the successful operation of the plan.

"c. The principle of free choice of physician and hospital by the patient must be assured to the end that the responsibility of the individual physician to the individual patient shall always be maintained. When hospitalization is required, this choice must of necessity be limited to the physicians and surgeons who hold appointments on the staffs of the hospitals participating in the plan or to those physicians and surgeons who are acceptable to the hospital. It is further recommended that only approved hospitals be admitted to participation in such a plan.

"d. The compensation of the physician and of the hospital should be estimated with due regard to the resources available in the periodic payment fund and should be based upon the specific services rendered.

"e The organization and operation of any plan of this type must be free from any features not in accordance with the code of ethics of the medical profession, which code has been established for the protection of the patient.

"f The medical organization participating in such a plan must assume responsibility for the quality of service rendered."

The American College of Surgeons condemns the practice which involves the sale of a contract by an industrial organization to an individual physician or group of physicians for medical or hospital services for its employees. Such a practice encourages commercial competition and should, therefore, be entirely eliminated.

It is my belief that the duty of assuming leadership in this movement rests with the medical profession and the hospital field, who should take control of all measures directed to this end. They should not frown upon new methods of practice designed to meet the needs of the public for medical and hospital care. Rather they are the ones who should encourage the trial of new methods. However new plans should be carefully evaluated as to the success of their results before they are offered for general adoption. And the evaluation must be made by the medical profession and the hospital field themselves.

THE DEVELOPMENT OF PERIODIC PREPAYMENT PLANS FOR HOSPITAL CARE IN ENGLAND

SYDNEY LAMB, M B E Liverpool There are at present in Great Britain over 6½ million subscribers to British Hospital Contributory Schemes, who with their dependents comprise approximately 15 million individuals assured of hospital care in case of necessity without additional cost to themselves. In June, 1934 there were 10 million employed persons compulsorily enrolled under National Health Insurance, and as the voluntary hospital contributory funds mainly include persons insurable under the National Insurance Acts it is evident that about two-thirds of the compulsorily insured population of England are also entitled to receive hospital maintenance. The official policy of the British Hospital Contributory Schemes Association is that all persons within the national health insurance income limit should ultimately subscribe, and that the total amount of their subscriptions should be sufficient to meet the full cost of maintenance in a voluntary hospital.

It was not originally intended that the subscriptions from the workmen and people of limited means would suffice to cover the cost of the hospital care that they would receive. It was felt, however, that the contributions received in this way would be much greater in total than the meager voluntary contributions made by these people at times of hospital illness. The British Hospital Contributory Schemes were not primarily insurance plans for distributing the cost of medical care among people accustomed to paying hospital bills at the time of their sickness.

The estimated average amount paid by English contributory funds to the voluntary hospitals is about ten dollars a week, equal to about 70 per cent of the actual cost of maintenance. This does not, of course, reimburse the hospitals for their services. But when one considers that English workmen as a class paid considerably less than half the cost of services received before the contributing schemes were introduced, the voluntary hospitals may be regarded as profiting by the new plans. There is a growing consciousness that English contributory funds must accept an obligation of meeting the full cost of maintenance of contributors in voluntary hospitals. A few schemes have done so. The contributors receive free care from the attending staffs of the hospitals, although procedures are in effect in some places by which members of the hospital staffs are paid from the contributing funds.

There are approximately 150 contributory schemes in England, and nearly every voluntary hospital participates in the benefits of a contributory fund, either as a single institution with a limited number of subscribers or as one of a group of hospitals serving an entire community. The larger funds hold membership in the British Contributory Schemes Association, which includes about 130 schemes.

The contributory schemes are usually organized on a community basis, as civic movements under the sponsorship of many important agencies. A "council" guides the activities of collecting funds from subscribers and making payments to the participating hospitals. Usually there is free choice, not only among participating institutions, but among voluntary hospitals elsewhere.

The hospital contributory schemes are officially and enthusiastically endorsed by the British Medical Association, which also recommends that self-supporting plans for the middle classes be adopted throughout the country.

THE HOSPITAL IN RETROSPECT AND PROSPECT

ALFRED M. SCHWITALLA, S J Ph D, St. Louis As the gospel of standardization is the ultimate ideal of civilization, so have we striven for standardization in hospital activity. Nature preceded standardization, and standardization is regarded as an improvement on nature. In early days one hospital was not like another in atmosphere, in effectiveness, in procedures, in personnel, they differed one from another.

Today we have the satisfaction of knowing that even though there are more hospitals than ever before they are also more uniformly better. We have given to the people the service which was demanded. Even though impossible demands have been made, the hospitals have not been content merely to say "this is impossible," they have done the impossible. They have made themselves—all in one—magnificent hotels, fully equipped scientific laboratories, schools for professional training, dynamic centers of social influence, nursing homes, and in many cases placement centers. No other single group of institutions has been expected to serve so

many, such diverse, and such important needs of today's civilization. And the hospital has fully answered the demands made upon it.

This impossible task has become possible through a clearer definition of objectives, a searching work analysis the adaptation of means toward the objective, the definition of requirements, and the enforcement, largely voluntary, on the part of hospitals themselves of the standards based upon needs and the tasks to be performed to fulfill those needs. In short, it has been made possible through the process of standardization.

And yet, in our efforts to bring institutions to a uniform degree of achievement and excellence have we lost nothing at all? It is a universal law of nature that everything achieved must be paid for in sacrifice—that success here means failure somewhere else. Is it not true that when all thinking is done all problems solved, and all difficulties answered by a uniform formula the institution ceases to live actively because it has ceased to vary actively? Each new adaptation in nature is only a precursor of a succeeding adaptation adaptation to environment when it becomes static spells death to type and individual. Adaptation which progresses spells greater excellence and greater perfection. I plead therefore, for increased activity of those internal forces which express themselves in initiative resourcefulness, new ideas, new applications, the research spirit, the conscious effort to variation. I do so because I cannot but be convinced that only by paralleling progressive standardization and progressive individuality can the hospital be of the greatest service to a constantly changing local and national environment.

My hope is that hospitals may be guided by the professional organizations which are re-creating them. But my further hope is that in that re-creation there shall be as much emphasis upon the *re* as upon the *creation* the re-creation implies permanency in the midst of transition. Let each hospital know what it stands for adopt the standards and the adaptations to a changing present with prudent wisdom in accord with its individuality and continue to serve in close co-operation and harmony with other institutions like itself the needs of this changing world. The hospital type will best be preserved by preserving the hospital's individuality.

FUTURE TRENDS IN HOSPITAL MANAGEMENT AND SERVICE

BERT W. CALDWELL, M.D. Chicago There is a constant tendency to increase the service of the hospital so as to benefit a larger number of our population. Our general hospitals (a majority of which are voluntary) are serving the public by providing in patient care, out patient care and in extending home care. General hospitals are developing a program by which the character of their service will be, both in purpose and in fact general hospital service. They are opening their wards to the care of mental cases. They are offering their facilities for the

accommodation and care of tuberculous cases—particularly in the incipient stages. There is a very definite tendency to use hospital service for communicable diseases instead of sending these cases to the contagious hospitals or to the so called pest houses. In developing this program the hospitals are affording improved opportunity for the training of internes and residents in psychiatric, tuberculosis and communicable disease clinics.

There is a definite movement in hospital service to provide prenatal care and to supervise the expectant mother during the prenatal and postnatal periods. There is a definite trend amounting almost to a maternal change, in the development of adequate maternity services in the general hospitals.

Hospital service is showing a marked tendency toward a closer association with the general diagnostic clinic the treatment and prophylactic clinics.

The larger problem in hospital management today is to encourage the use of existing hospital facilities. It is the hope of the hospitals that every person suffering from any disability or disease whatsoever may have the advantage of competent hospital care in a hospital near his home, at the earliest moment, without inconvenience to himself or family and without economic disaster following his hospital care. The utilization of existing hospital facilities with each institution giving a satisfactory professional service, would solve the economic difficulties, not only of the institutions themselves, but of the members of the medical and nursing professions who staff them.

There are not sufficient hospital facilities in the metropolitan centers of the country—in the tax supported institutions, in the municipal and county general hospitals—to take care of the indigent sick who apply for admission. Had it not been for the voluntary hospitals service to the sick poor during the past 4 years, the people of this country would have suffered beyond any conceivable measure.

There must be full recognition of the fact that the changing era has brought varied problems, and that the old order of things, so long established must change to meet the new challenge and serve the best interests of public, physician, and hospital alike.

Leadership in thought and action must come from these associated groups. This leadership must develop that order of thought that system of procedure, to which the public will give its sympathetic co-operation the system that will secure a unanimity of support, and that will provide on the one hand the desired medical and hospital care for all of our people, and on the other hand a fair remuneration for the services which physicians and hospitals render.

THE PROPER INTERPRETATION OF HOSPITAL SERVICE

NEWTON E. DAVIS, D.D. Columbus, Ohio Hospital service properly interpreted, includes the very best type of organization as it relates to the manage-

ment and departmental service of the hospital. The importance of saving human life makes it necessary that the very best trained personnel be placed in charge of the organization which is responsible for the planning of the institution. For too long a time organization under trained leadership has been for tuitous, rather than required in hospital service. Too many hospitals have been merely boarding houses with some facilities for the nursing of the sick.

The modern hospital must meet all the requirements of the highest form of organization in its every department. This requisite covers trained experts in accounting, business administration, and departmental organization. The hospital is responsible for the technical service which is rendered to the patients. It is, therefore, necessary that all of the technical service such as laboratory, X-ray metabolism, and other types of special service, shall be conducted by people who are specially trained to handle the departments to which they are assigned.

A proper interpretation of hospital service as it relates to the standard of medical and surgical practice has been made by the American College of Surgeons which, through its promotion of staff organization and departmentalization of medicine and surgery has laid down fundamental principles which should be recognized and followed by every hospital in the world which expects to render the highest type of service to the patient. Every new procedure which the American College of Surgeons has set forth during the past 15 years has been a step in the right direction. But the hospitals have been slow in accepting these high requirements, and many are yet without the necessary standardization and staff program, hence are not rendering to the public the type of scientific service which they could render if they were properly standardized.

Marked advance has been made in nursing education in the United States and throughout the world in general. The insistence of the American College of Surgeons that medical and surgical practice be of the highest type has necessitated improvement in the theory and practice of nursing service. The progress made has been in keeping with the increased efficiency and effectiveness in hospital organization, technique and standardization. The hospital which merely runs a boarding school for young women, with some practical nursing service, cannot qualify today under the heading of a modern hospital.

The hospital has long passed the period of being merely a life saving institution. The proper interpretation of the modern hospital leads us to state that a hospital must, through its visiting nurses, its interne service as well as the service of the medical and surgical staff, consider the public as a vital part of its program. The relationship of the hospital to the work of public agencies, such as child welfare organizations, public health clinics, and the agencies which are working socially for the control of epidemics and communicable diseases, must be established. In this regard the hospital acts as a co-ordi-

nating unit which relates the individual who is ill to the community as a whole, and likewise brings the public into a definite social relationship with the hospital.

PRINCIPLES GOVERNING THE RELATION OF RADIOLOGISTS TO HOSPITALS

ARTHUR C. CHRISTIE, M.D., Washington, D. C.
The radiologist must be a duly licensed physician with adequate training and experience in all branches of radiology. The radiological department must be under the direction of the radiologist, and be or a qualified assistant must spend ample time therein to see every patient and to supervise every examination or treatment. His service must be such as to insure the element of medical consultation in every case examined in the department. His financial arrangements with his patients must be the same as those of other members of the staff; that is, he should fix the fee for services in each case. His financial arrangement with the hospital must be such that the hospital receives ample payment for all expense incurred by it, including a sufficient amount to cover obsolescence of apparatus. On the other hand, the hospital should not make a profit from the operation of the department nor in any way share or fix the fees of the radiologist.

Much advantage accrues to the hospital when the radiologist draws to his department a considerable percentage of his work from outside. The hospital increases its prestige by having a first-class radiological department and increases its percentage of bed occupancy through the hospitalization of patients being treated in the radiotherapy department. An additional advantage of great importance is that this is a method by which a hospital of even moderate size may have a first-class radiological department which is entirely self-supporting. Such advantages quite offset any advantage to the radiologist from his so called monopoly of the work in that hospital. It has been said that the hospital must offer to the radiologist a special "concession" but the fact is that the "concession" is mutual. The radiologist must abandon the advantages of private office practice, must be subject to the calls of emergency work, and must do a much larger percentage of charity work than he would in a private office location.

In addition to routine duties which require full time service in the hospital, the radiologist must do his part in instructing internes and residents, also in attending and taking part in all clinicopathological conferences of the staff. Furthermore, he must have frequent consultations with the hospital pathologist on cases studied by both.

The American Board of Radiology has now taken its place among the examining boards for the specialties and there are already indications that it will exert a most wholesome influence in raising the standards of radiological practice. It is confidently expected that hospital accrediting and standardization agencies will presently require that the heads

of radiological and other special departments shall be diplomates of the special examining boards, thus helping to insure high quality of service in every department.

STANDARDS FOR OBSTETRICAL SERVICE IN HOSPITALS

GEORGE W. KOSMAK, M.D., New York. When we discuss standards we must have in mind not the adoption of mere routine procedures which are applicable to all cases, but rather the adoption of those procedures which have been found by trial and experience to be the safest and most suitable. Then we must make use of them in the individual case with whatever modifications may be necessary.

It should be the aim of good obstetrics to restore the patient to her previous natural life. She may have been severely damaged by a labor accompanied by operative delivery. Her generative organs may be displaced, her genital tract lacerated, her kidneys damaged and other organs affected in such a manner that they have not returned to normal, and yet she may have failed to show these conditions through a rise of temperature. The arbitrary interpretation placed on temperature readings in most hospital services is evidently in need of revision.

The development of adequate standards for the hospital care of pregnant patients will be reflected in the home care of such women. In addition to so called standards we must consider other factors in hospitals that influence recovery. It must be admitted that the increase of hospital deliveries has not resulted in a corresponding decrease of maternal mortality and morbidity. Hospital confinements in many instances seem to have degenerated, if I may be allowed that expression into more or less artificial forms of delivery and it is worthy of note that in many sections of this country the operative incidence has increased by leaps and bounds during the past few decades. Also worthy of note is the considerable variation among individual institutions. Large public hospitals report over 90 per cent of normal deliveries, private hospitals well known and acknowledged to be excellent, show less than 50 per cent of normal deliveries.

Undoubtedly reform in hospital management of labor cases is necessary and there is equal need for developing standards which will improve the situation.

OBSTETRICAL COMPLICATIONS IN THE WOMAN'S HOSPITAL, NEW YORK, STUDIED IN ORDER TO ESTABLISH PROPER STANDARDIZATION FOR STATISTICAL PURPOSES

GEORGE GRAY WARD, M.D., BYRON H. GOFF, M.D., and ALBERT H. ALDRIDGE, M.D., New York. The usual practice of obstetrical clinics in reporting their maternal morbidity in percentages based on fixed postpartum temperature criteria is of little value for comparison, since there is no uniformity in the methods employed. At best it is only an

accurate index of possible puerperal sepsis, and takes no account of the many other serious complications which are certainly morbid." We believe the object of reporting maternal morbidity should be to establish data as to whether or not the function of bringing a child into the world has been a normal process. Therefore if a woman at any time during her pregnancy, labor, or puerperium has a condition or disease which complicates the process of child bearing so that it is not normal, it should be classed under the heading of maternal morbidity if this term is to be used, irrespective of whether the abnormal condition has a certain degree of postpartum fever as a symptom. We believe that temperature alone is an insufficient and in many instances an inaccurate criterion to use if we would correctly classify our morbid cases.

Studies of our cases show that certain patients have significant postpartum complications without any elevation of temperature and that some patients have complications with slight persistent febrile reactions who would not be considered morbid by any of the prevailing criteria.

If our purpose is to determine whether or not a certain pregnancy is normal we believe that the case should be considered throughout the entire process from the onset to the completion of the involution. Therefore, the antepartum, intrapartum, and postpartum complications should be included in statistical studies, instead of basing maternal morbidity rates on one symptom alone, namely a rise in temperature. Then we will be able to have a much better appreciation of the price of childbearing and the efficiency of our care.

For purposes of comparison and evaluation of methods, a knowledge of the temporary or permanent maternal disablement of our patients as a result of childbirth will be of more value than the estimation of possible sepsis as indicated by a single rise in temperature which is all that the "morbidity rate now in vogue means."

Our objections to present criteria for so called 'puerperal morbidity' may be summarized as follows: (1) criteria are not uniform; (2) criteria are based entirely on one symptom—rise in temperature; (3) certain patients have significant postpartum complications without any elevation of temperature; (4) certain patients have significant complications with slight persistent, febrile reactions, who are not considered 'morbid' by any of the present criteria.

We feel that there is an urgent need of a uniform standard for the determination of maternal morbidity. Such a standard should be based on consideration of all symptoms and physical signs rather than upon a single symptom. We suggest that the standard be sponsored by a national organization such as the American College of Surgeons. We would suggest that the term 'puerperal morbidity' be abandoned because of its vagueness and the conditions and diseases associated

be classified under three headings namely ante-partum, intrapartum and postpartum complications, as has become our practice at the Women's Hospital during the past year

REGULATION AND CONTROL OF OBSTETRICAL PRACTICE OF NON-STAFF PHYSICIANS IN INSTITUTIONS

SAMUEL A. CONGROVE, M.D. Jersey City In no field has the liberalization of staff practice been broader than in obstetrics. Many a general hospital the surgical service of which remains uncompromisingly closed, permits a wholly open field to anyone desiring to admit obstetrical patients. And in no other field is such untrammelled practice by physicians of little or no special competence capable of such tragic results.

Through questionnaires sent to 46 general and special hospitals, it was found that 71.4 per cent of the obstetrical services are "open" so far as private patients are concerned, only 5.7 per cent so far as public patients are concerned. Of the total services "open," only 70.4 per cent claimed control of practice.

Hospitals generally would fall into 5 classes so far as control of obstetrical practice is concerned. In the first group adherence to technique only is required. Control by indirect moral suasion only is exercised in group two. In the third class are those hospitals which control by courtesy staff grading. Control is achieved in the fourth group by restriction of appointment to courtesy staff. In group five control is by specific requirements of consultation, strongest where such requirement is universal and unequivocal.

The establishment of paper rules by no means suffices to safeguard patients. Some provision must be made for the constant contact of the institution with the patients. Thus the Margaret Hague Maternity Hospital provides through residents, young men of adequate obstetrical training and competence, who are constantly associated with the courtesy staff attendants in estimating obstetrical situations from time to time. This association is unobtrusive, tactful, and is usually welcomed by the attendant. Indeed, so dependent do some physicians become on the residents that it has been necessary to issue a specific ruling against the residents exercising a consultative function in relation to them.

Occasionally however the outside man resents the surveillance of his work and it is then necessary for the resident to act with firm decision, forbidding illicit interference if necessary pending contact with executive authority. We cannot escape the fact that hospitals do owe a direct moral responsibility to all patients admitted and must see to it that they receive medical care of high competence even if the physician of the patient's choice be not capable of giving it without the augmentation of his capacities through the consultation and assistance of others.

In any hospital, the adoption of regulations pertaining to the work of the attending staff must be reinforced by constant, active scrutiny of their

actual operation by a chief or director with definite executive power lest regulations become non-effective.

In the Margaret Hague Maternity Hospital no mother has ever died because she was permitted to remain in the sole care of an inadequately trained and inexperienced practitioner. Such a splendid record would justify every institution's maintaining rigid control of practice.

DISCUSSION

JAMES RAGLAN MILLER, M.D. Hartford I believe that hospital reports should have, each year a concise statement showing the background of the clinical material. Is the staff open or closed? What proportion of its cases are residents or non-residents? What is the proportion of residents compared to total deliveries of the city's residents? What kind of patients are represented—economically? Racially?

Before evaluating any hospital report one should know whether each physician is careless about summarizing his history on discharge or whether a benevolent despotism forces him to do truthful and accurate reporting. There is undoubtedly a drive on for more accurate and thorough control, and hospital staffs should realize that if they are unwilling or unable to exercise this control, the lay management of the hospital is going to exercise it in a more direct and perhaps less pleasant manner. At present, most of our organizations fighting the battle of maternal mortality and morbidity are controlled by committees, a method which is not calculated to produce good results.

In our community hospitals it is almost impossible to get the obstetricians to write the history and physical examination on their private patients' records. Most private patients resent a perfunctory history and physical examination done by an intern a day or two after delivery. In order to span this gap we have persuaded the Connecticut State Department of Health to print and distribute an obstetrical reference card to all physicians doing obstetrics. It is urged that the record of the first examination be sent forthwith to the hospital where confinement is to occur. This will be of service to the hospital in gauging its prospective number of births in supplying information which is now often lacking on the histories. It will also be of service to the obstetrician himself who arrives at 2:00 a.m. for example, to deliver Mrs. X and who does not recall what he found at his first examination.

If hospitals will furnish this prenatal record on their own stationery it will be much more satisfactory. The success of the "Medical Reference Card" for general cases which has been used in Connecticut for the past several years has been such as to lead us to believe that the obstetrical card will also meet a need.

THE FUNDAMENTAL PRINCIPLES UNDERLYING THE MECHANICS AND TECHNIQUE OF STERILIZATION

HURLEY T. WYATT Madison, Wisconsin Since the time that Pasteur and Lister made their out

standing contributions to surgery the development of the processes and technique of sterilization has been among the most important contributions to modern surgery. The work of surgery is largely dependent upon an abundant quantity of sterile surgical supplies. The slightest carelessness on the part of anyone who has to do with the preparation and handling of these surgical supplies may endanger the life of the patient and render the work of the most skilled surgeon of little avail. A rigid asepsis must be maintained from the time the patient enters the operating room until the surgical wound is healed and the patient discharged.

The sterilizing equipment of the hospital plays a most important part in producing and maintaining this necessary aseptic condition. For this reason the surgery and its allied departments have the right to insist that they be provided with the best and most efficient sterilizers that can be built to aid them in their important work of saving human lives. But the best sterilizers are not all that is required for after such equipment has been secured it is not only imperative that it be properly maintained but also that it be promptly and effectively serviced by competent and efficient help.

The function of the sterilizer is to kill pathogenic bacteria. Its efficiency depends entirely upon the thoroughness and completeness with which this is done. The most effective way of destroying bacteria is by coagulating or solidifying the protoplasm of the cell. This is accomplished through the medium of heat and it has been found, through laboratory experiments, that the degree of heat required will depend upon the conditions under which the heat is applied. Authoritative observers do not agree on the exact degree of heat required to kill the more resisting types of pathogenic bacteria. Their findings range from 230 degrees to 248 degrees F. This heat to be applied in the form of moist steam for a period of time ranging from 5 to 25 minutes. All will agree that the work of destruction will be effectively accomplished if the disease producing bacteria are subjected to a moist heat of 250 degrees F for a period of at least 25 minutes. To insure a conservative margin of safety the pressure sterilizers should be operated for a period of 30 minutes under a steam pressure of 18 pounds which will provide a moist heat of 255 degrees in the sterilizer chamber. This will give a temperature of 5 degrees higher applied for a period of time 5 minutes longer than that recommended by the best authority. Even this condition however will not always guarantee a complete sterilization of the dressings. A moist heat of at least 250 degrees must thoroughly penetrate to the center of the packs of dressings and be maintained there for the required period of time. Unless this is accomplished, all germ life present will not be destroyed even though there is a temperature of 255 degrees in the sterilizer chamber. It is important to know that the proper temperature and moisture reach the center of the largest pack of dressings that is being sterilized. This can be assured by packing

the dressings properly in the sterilizing chamber from which the air has been removed. By means of the vacuum ejector and other devices that have been provided on modern sterilizers, air can be removed, thus insuring the necessary penetration of the dressings.

A SCIENTIFIC ANALYSIS OF STEAM IN STERILIZING, SHOWING HOW PRECISION METHODS MAY BE SUBSTITUTED FOR THE INDEFINITE METHODS NOW IN VOGUE

WEEDEN B. UNDERWOOD, Erie, Pennsylvania
The greatest handicap encountered in establishing safe sterilizing systems is the heritage of misinformation about steam that has been handed down from the period of the introduction of steam sterilizers. Nurses have been taught to gauge sterilization by the inexact method of measurement of pressure rather than temperature.

The temperature of steam is the one bacteria destroying property. Pressure is only incidentally important. Steam is effective in sterilizing at relatively low temperatures by virtue of its moisture content. Saturated steam, as produced in the normal sterilizer, contains a definite amount of moisture. Its only variable factor with respect to its sterilizing properties is temperature. It is known that saturated steam at a temperature of 240 to 250 degrees F. corresponding to pure steam at 10 pounds pressure, will destroy all pathogenic organisms in a brief interval of time.

The relation of pressure to temperature in saturated steam is dependent upon the degree of air evacuation from the sterilizer. At 15 pounds pressure, the maximum temperature to be secured within the load of surgical supplies may vary between 212 to 250 degrees F., depending upon the degree of air evacuation.

The pressure of air in the sterilizing chamber adversely affects sterilization in four distinct ways: the maximum possible temperature will be reduced; there will be radical variations in temperature in different parts of the chamber for an appreciable time; the time required to reach a uniform degree of temperature will be seriously prolonged; the penetration power of a mixture of steam and air is far less than that of pure steam.

Sterilizers operated by pressure without measured regard for air evacuation and resulting temperatures often become hazardous. The performance may be anything from excellent to very poor but neither result is in the slightest degree indicated by the pressure gauge. Tests in hospitals show glaring inconsistencies. For example, a machine operated at 18 pounds pressure for 30 minutes developed a maximum temperature of 151 degrees F. A machine operated at 20 pounds pressure for one hour developed a maximum temperature of 220 degrees F. A machine operated at 20 to 29 pounds pressure for one hour developed a maximum temperature of 251 degrees F.

Standardization of sterilizing procedures needs to include details of loading and preparation of supplies. Rarely are there two hospitals found using identical methods. Movement of air and steam within any sterilizer is always actuated by gravity from the top toward the bottom, which fact has significant bearing on loading and preparation.

There is rather radical conflict of ideas relative to the requirements for sterilization, due probably to past inaccurate methods of gauging performance by pressure. Some authoritative body should clearly define limiting temperature and time factors, in order to bring about safe standardization and to accomplish practical, sensible reforms in sterilization procedures which will be less expensive.

OBSERVATIONS ON STERILIZATION OF DRESSINGS WITH SPECIFIC REFERENCE TO STERILIZING CHAMBER TEMPERATURES AND THEIR RELATION TO STERILIZER CHART TEMPERATURES AND CULTURES

S R D HEWITT M.D. and LYLA C BELDTYD, R.N. St John, New Brunswick. One year ago we began a study of our sterilizing practices, mainly with the idea of establishing a relationship between the temperature as recorded on the steam and pressure chart of each sterilizer, and the actual temperature as recorded by a reliable thermometer in various locations within the sterilizing chamber, more specifically within bundles in the center of drum, center of ordinary bundles, in solutions, gloves, powder, etc.

We observed that by preliminary heating of the sterilizer that is, the steam jacket, for a few minutes before proceeding with the development of vacuum and actual sterilization, it was relatively a simple matter to produce regularly a vacuum of approximately 15 inches. The vacuum was more rapidly and, what is more important, more completely obtained, by the preliminary heating. Our sterilizers are inspected every day by our chief engineer and all screens are cleaned not less frequently than once daily.

The minimum sterilizing temperature of 255 degrees F required by our procedure was not reached within the bundle in the center of the drum, in all instances, until after 30 minutes had elapsed. What was recorded for this interval held good for all subsequent intervals, up to and including 60 minutes. Theoretically therefore, our temperature chart would lead the unwary to believe that the goods to be sterilized were exposed to our required temperature for an hour. Actually we have satisfied our selves that it requires the lapse of one-half hour before that required temperature is reached in all instances.

From the observations made in 686 temperature studies, 616 of which were submitted to our pathological department for bacteriological study, we feel justified in arriving at the following conclusions: (1) we have satisfied ourselves that our sterilization practices are eminently safe. (2) we believe that we can obtain more complete vacuum by preliminary

heating of the jacket, (3) we believe it should be possible to reduce the time required for our sterilizing procedures. (4) there is a fairly considerable and consistent discrepancy between the thermometer intra-drum, bundle etc. temperatures and the temperature on the steam chart in the majority of instances, during the early periods of sterilization. (5) we are unable to satisfy ourselves that there is any method as safe and accurate as that of utilizing a thermometer within bundles. (6) there is a very definite irregularity of behavior of steam penetration, under identical conditions so far as we can produce them. For example, of the intra-drum temperatures reported at sterilizing level, by thermometer there is a spread of 19 degrees, one bundle showing 235 degrees, another bundle 254 degrees. At 20 minutes, just taking this interval as an example, we find that this group study did not, relatively speaking, do as well from the temperature standpoint as those studied at 15 minutes. As expected, the discrepancies gradually became less, until at the end of 30 minutes, speaking of drums again, our final records show only a difference of 3 or 5 minutes.

CHECKING AND CONTROLLING POSTOPERATIVE INFECTIONS

HAROLD L. FOSS M.D. Danville, Pennsylvania. Some form of complication accompanies a certain number of all surgical operations in the best of our hospitals even when the most modern technique is used. However such complications should be kept at an irreducible minimum. Possibly even with the greatest care, 5 per cent of operations will be followed by some complication.

Of all complications approximately two-thirds have to do with the wounds themselves. Fortunately most are innocuous and are the result of contamination with the ordinary skin coed. A high percentage of wound infections following "clean operations" is inexcusable. Catgut plays a certain rôle, but relatively few complications are the result of infection introduced by the suture material alone.

Most postoperative wound complications result from actual "breaks" in surgical technique, the types and varieties of which are legion. Some of the more common are insufficient sterilization of instruments, gloves, and gowns; insufficient preparation of the hands of surgeons and nurses; carelessness on the part of the surgeons or nurses in the handling prior to coming to the operating room, of infected material—all too frequently infection is transmitted as the result of unintentional carelessness in matters of personal hygiene. Sporadic occurrences of wound complications resulting from infection with the hemolytic streptococcus are frequently traceable to certain members of the operating room personnel who are carriers and who constantly harbor the organisms in their upper air passages. A careful masking of the mouth and nose of each person in the operating room will eliminate this source of infection.

The incidence of postoperative wound infections varies according to the location of the operating

room. For example on the ground floor it will be relatively high while on the top floor it will be relatively low. It likewise varies according to the degree of scrupulous cleanliness with which the room is kept, the number of people in the room and the extent of disturbance.

Every well conducted hospital should have a careful record of postoperative complications, particularly a list of postoperative wound complications and infections. If they occur consistently with a frequency above the normal or irreducible minimum the fact should be made known immediately to the superintendent the chief of staff or some individual in authority whose duty it should be to take steps to correct the evil. Furthermore, every operating room employee and every surgeon operating in the institution should be constantly aware of the presence of such a record and should be willing and ready whenever the incidence of trouble with operative wounds is excessive to institute a thorough investigation with the object of improving conditions promptly. A surgeon who regularly has a high incidence of infected wounds following operations performed on clean cases should not be long tolerated in the modern hospital, and by the same token the superintendent who being aware of an abnormal incidence of wound infections on a certain service does nothing about it, should be replaced by someone more conscientious and competent. Civilization has advanced too far to permit such laxity. The clean surgical patient has a right to expect a clean hospital a clean surgeon and, following the completion of his operation, a clean postoperative wound.

SOME SOCIAL AND PERSONAL PROBLEMS OF SURGICAL PATIENTS

IDA M. CANNON Boston Medical social workers whose professional function is concentrated on the patient as a person and on his human relationships wish that it might be made clearer to surgeons that our interest includes not only the surgical end result, but more especially what is happening after the surgical end results are dismissed from attention. We believe that the patient would benefit from more satisfactory co-operation between surgery and social service in this area.

The relation of character and personality to the experience of sickness has always been a subject of major interest to social workers. We have considered that our service was primarily concerned with character under adversity and that sickness and pain and facing of death and prolonged crippling disease brought special tests of character.

We are hearing increasingly these days of the introduction of psychiatry into the general hospital, the purpose of which is better understanding not only of functional disease but also of the functional factor so often present in organic disease. The contribution of psychiatry to medicine is only beginning to be appreciated, or at least so it seems to many of us social workers who are turning to psychiatry for deeper insight into human motives and the conflict

ing forces in personality. May not psychiatry have something to give to a better understanding of the patient in the surgical ward where we see at work the forces of fear and loneliness and bitterness which have been called retrogressions of spiritual growth? I believe that both psychiatry and religion should have something to contribute to these problems.

It is the psychic shock in surgical experience that would seem to need exploration. At least we may become more skillful in preparing the patient who for the first time faces the startling experience in the hospital ward and operating room which to us are so very familiar and congenial. Surgeons often state that their skill is to give nature freedom to do her mysterious work of repair. The patient must of course be the one who must finally struggle through the personal problems. Collectively may we not attain finer methods of freeing the patient to make more satisfactory repair of the psychic wound? May we look forward to the time when evaluation of end results will cover not only the physical findings and the functional capacity such as are noted in the end results of fracture cases but will also seriously consider the capacity of the patient to carry on in his human relations? I realize that personality and character offer probably the greatest variables but this serves to emphasize the necessity for more earnest consideration of the problem.

EXPERIENCE WITH A HOSPITAL FOR PEOPLE OF MODERATE MEANS

MORGAN J. RHEES, M.D. Boston The Baker Memorial, the department of the Massachusetts General Hospital for patients of moderate means, has now been in operation for 4½ years. An increasing number of patients has been cared for each year. The Baker Memorial plan is summarized as—

- 1 The offering of moderate rates for bed care and for special services in a hospital unit large enough to facilitate economical administration.

- 2 Co-operation with the medical staff whereby moderate fees are charged for professional services.

- 3 The unifying, by consent of the medical staff of all financial dealings with the patient under the hospital administration so that the patient is not presented with two or more independent bills for hospital and professional care, respectively but with a single bill collected by the hospital, which in turn passes over to the physician his agreed fee.

- 4 An endeavor to minimize the amount and cost of special nursing.

- 5 An effort to provide all the service at cost, without charity and without profit.

The rates charged for board and other services are designed to cover the costs, with the building occupied to about two-thirds of capacity. A sufficient number of floor nurses is provided so that special nursing is seldom necessary and is allowed only if a patient needs more care than can be given by the floor.

Practice in the Baker Memorial is limited to members of the staff of the Massachusetts General Hospi-

tal and the Massachusetts Eye and Ear Infirmary. The staff has agreed to a schedule of limited professional fees, with a maximum of \$150, regardless of the length of stay or number of physicians involved. The hospital undertakes to see that only patients of moderate means, who cannot afford to pay higher fees, are admitted. Of 100 consecutive admissions the average income was \$2,772. 80 per cent had incomes less than \$3,000. 54 per cent less than \$2,000. Requests for admissions from people with incomes less than moderate are much more numerous than from those who might be considered as well-to-do. Ninety-seven per cent of the patients are referred to the hospitals by members of the staff; only 3 per cent come directly from other doctors.

The Baker Memorial has not yet become self-supporting. It is hoped that it will be when occupied to about two-thirds of capacity. The first 4 years had a deficit averaging \$63,000 a year. For the first 3 years the Julius Rosenwald Fund agreed to pay half the deficit. The balance and the entire deficit after the third year must be carried by the charitable funds of the Massachusetts General Hospital. In 1934 there has been a greater occupancy and a smaller deficit. The coincidence of increased occupancy with increased business activity would seem to indicate that with economic recovery the Baker Memorial will be able to pay its way.

A TRIAL OF THE EIGHT HOUR DAY FOR HOSPITAL SPECIAL NURSES

SALLY JOHNSON, R.N. Boston. A review of a trial period of the 8 hour day for hospital special nurses was made during the 5 months, May through September, 1934, at the Massachusetts General Hospital and the Massachusetts Eye and Ear Infirmary. A comparison with 1933 was difficult, as the necessary data were not recorded, but based upon the statistics which were available, the following statements are of interest.

During the trial period, there was a daily average in the two institutions combined of 731 patients. The number of calls for special nurses which were filled was 3,778. The morning period of service is from 7:00 a.m. to 3:00 p.m., the evening from 3:00 p.m. to 11:00 p.m., the night from 11:00 p.m. to 7:00 a.m. The charge for each period is \$4.50 to the nurse, and 25 cents to the hospital for each of two meals, making a total cost to the patient of \$15 for 24 hours of service. Under the new system, the hospital itself has thus far not added to its personnel. The changes in cost to the patient with the 8 hour plan were reported to be as follows: General Hospital, average ward patient who was specialied, an increase of \$16.05 per patient per month (part of the increase in 1934 was due to the special apparatus required for several patients in for long periods of special care); Phillips House (private pavilion) increase per patient of \$8.50 per month; private pavilion of Eye and Ear Infirmary increase per patient, \$7.78 per month; Baker Memorial (for persons of moderate means) a decrease per patient of \$1.08 per month.

In reply to a questionnaire sent to the 3 groups most vitally concerned, 135 nurses gave unanimous approval of the 8 hour day. Of 100 physicians, 6 reserved an expression of opinion, 13 did not approve. 6 approved with minor reservations, 75 fully approved. 250 patients replied as follows—13 had no basis for comparison, 30 disapproved, 212 approved without reservation. The data of comparative earnings and days of employment seem to indicate an increase in both figures. However, it must be remembered that few nurses had accurate figures for 1933 so that the number of studies was small, and that a nurse now has to pay for one meal daily which formerly was furnished.

Reliable records of the employment of individual nurses show that the 8 hour day has brought speed of employment. At the Baker Memorial, during a period of 5 months in 1933, 149 nurses were employed, while during the comparable number of months in 1934, 258 nurses were employed. There was some increase in the daily census of patients, but not sufficient to produce this spread of employment. In the Phillips House during 5 months of 1933, 180 nurses were employed during the comparable 5 months in 1934, 223 were employed. The daily census was only slightly higher in 1934. In the general hospital in 1933, 122 nurses were employed during the 5 months during the comparable 5 months of 1934, 193 nurses had employment. There was practically no change in the daily census of patients.

Based on 18 years of interviewing prospective applicants to schools of nursing, I am of the opinion that an 8 hour day for hospital special nurses will do much to reduce the parents' objections to nursing as a vocation for their daughters. I believe that this change will bring more young women who possess integrity of character, an acceptable social background, attributes of desirable personality and a higher level of education, to the profession of nursing. Any plan which will tend to accomplish this result is worthy of serious consideration, for it will improve nursing from the standpoint of the hospital, of the nurse, of the physician, and of the patient.

HOW I, AS A HOSPITAL TRUSTEE, VIEW MY RESPONSIBILITY

IDA M. CANNON, Boston. The first duty of a trustee is to accept as the central purpose of the hospital the skilled and ready care of the sick and injured. In so far as the hospital provides an opportunity for education of internes and nurses, this educational function should be secondary to the care of the patient. It is a happy fact that the higher the quality of consideration and care of the patient, the better will be the basis for good teaching of doctors and nurses. The trustee must be interested in listening to any serious complaints about service. The sympathetic hearing of such complaints often results in the issue disappearing into thin air; explanations can often be made that disarm the critic. If there is ground for complaint the duty of the trustee is to express gratitude for having the situation brought to

official attention and to make every effort to have it corrected.

Next to obligation to the patient is loyalty to the professional groups within the hospital. There should be respect for each position in the organization. There should be scrupulous care not to undermine the authority of those placed in positions of authority and responsibility. Deference is due the professional groups when questions concerning professional service are brought to the board of trustees for consideration.

Community relations should be of special concern to the trustees. It should be remembered that in accepting the appointment of trustee one is not only a special representative and interpreter of the hospital to the community but also a special representative of the community to the hospital. There should be a sensitive interest in a program for the hospital that will take into account the changing needs of the community. There should be a feeling of responsibility for keeping abreast of the most progressive thought concerning hospital administration.

The position of a hospital trustee is one of those elastic responsibilities that cannot be measured in hours of service. The board is invariably made up of busy people who must fit this extra service into already crowded hours. It therefore rests with each trustee to see the full scope of the responsibility accepted by the group making up the board of trustees. Within that joint responsibility there is the obligation on each trustee to see what special contribution he can make so that collectively there may be within the board an integration of special contributions.

HOW I, AS A HOSPITAL PRESIDENT DISCHARGE MY DUTIES

FULLER BARNES Bristol Connecticut I have always felt that experience is one of the best teachers, and that the president of a hospital if he is at all active, must necessarily have an intelligent knowledge of all departments and of as much of the work as possible.

Each year in our institution the trustees appoint 8 members to an executive committee, 5 laymen and 3 doctors. The medical and surgical staffs, which are well organized nominate 3 of their own members to this committee each year. The executive committee meets once every month with the superintendent. Each member knows exactly what he is responsible for and takes an active interest in seeing that the various departments function effectively. This relieves the president of much worry and is an ideal situation from his standpoint. There is a separate committee for the training school of which the president is chairman.

The trustees of the hospital meet at the call of the president, once a year for the annual meeting. They are men of standing and means in the community who have the interest of the hospital at heart, but their positions are more honorary than active. Each year they go over the progress of the

hospital and to a large extent follow the recommendations of the president and the executive committee for the following year.

I feel it my duty to work closely with the finance member of our executive committee. I endeavor to attend the session of the committee of the Connecticut Legislature having to do with appropriations to hospitals, and attempt to keep the appropriation in line with what we feel we should have. As a trustee of the Community Chest I endeavor to see that the hospital receives a budget allowance adequate to meet the running needs of the hospital. The budget committee is composed of the chairman of the executive committee, the finance member and the president. We run on a very strict budget which is checked each month. Bristol Hospital has never been in debt.

I have always taken a great interest in keeping the public informed as to what the hospital and training school are doing endeavoring to see that we get publicity of the proper sort and that the public knows items of interest in regard to its hospital. For this reason we distribute widely our annual report.

I consider it the duty of every active president to visit his hospital at least once every 10 days, oftener if possible to talk over current events with the superintendent who appreciates moral support and a close sympathetic understanding. While visiting the hospital I endeavor to call on as many patients as possible and talk with the nurses and doctors in an effort to maintain the spirit of co-operation and friendliness which is so essential.

Having delegated authority whether to a committee, the superintendent, or an employee, the president should never go over their heads, but work through them in whatever questions may arise. He must not delegate too much to his subordinates and should not permit problems which should be settled to remain unsettled. The president must maintain a capable and friendly organization in which all committees and employees work together in close harmony so that no problems are allowed to get beyond control.

HOW I AS A TRUSTEE, JUDGE THE EFFICIENCY OF OUR HOSPITAL

INGERSOLL BOWDITCH, Boston The trustees are responsible for the policies of the hospital if they allow the superintendent or the staff to dictate these policies efficiency will be decreased. Trustees may be sure that their hospital is not lacking in efficiency if it is approved by the American College of Surgeons approved for internship by the American Medical Association, and its school of nursing approved by the State Board of Registration.

In studying the efficiency of a hospital the book keeping department is an excellent place to start. The daily record of patients will give an idea of whether the doctors are making use of hospital facilities. The treasurer's monthly statements will show if expenses are being met. Statistics from the

record room files will reveal many important facts. A trustee may learn what the mortality is in maternal cases and what percentage of patients are being discharged relieved or not relieved. Another good place to check efficiency is in the boiler room. This can be under the supervision, in addition to that of the superintendent of a trustee who has a technical knowledge of how boilers should be fired.

Doctors are generally very free in their criticisms of the way a hospital is run and by talking with them informally a great deal can be learned. At least once a year at my hospital the medical and surgical staffs meet with the trustees and are given an opportunity to make suggestions. At least one member of the staff is on the executive committee and he is able to keep the committee informed as to how the doctors feel in respect to the efficiency of the hospital.

It is a good plan to place each trustee on a different committee so that he can come into contact with special activities. The monthly meetings are made more interesting by the reports from each trustee who is able to impart knowledge concerning a specific department.

An excellent way to learn whether a hospital is filling the needs of a community is by reading letters written to the superintendent by patients who have been discharged. Another means is by judging the type of internes. If a hospital can get internes who were graduated near the head of their class at medical school it is safe to say that the institution will be efficient.

If a trustee is willing to give the time, he can easily learn whether his hospital is being run efficiently—not only by attending the trustees' meetings but by visiting the hospital at various times, day or night, by being on friendly terms with the doctors and all those who are connected with the hospital, from the superintendent to the orderly and by being a member of at least one committee of the trustees. The more you know about your hospital the more pleasure you get out of being a trustee.

TUMOR CLINIC RECORDS

JAMES T. NIX, M.D. New Orleans. It is possible that the solution of the cancer problem rests with the tumor clinic record. To be adequate it is essential that the record have completeness and accuracy coupled with simplicity. Long questionnaires are undesirable because they lack flexibility that is, adaptability to the individual case. They tend to stress form rather than content and make for perfunctory stereotyped, mediocre records. Nevertheless, there are certain necessary points of information which must be contained routinely and unless furnished on the printed page these points may easily be overlooked and neglected, much to the detriment of the record. Uniformity and standardization are therefore desirable and necessary but they must be tempered with sufficient elasticity to preserve the individual features of every case.

The following is an outline of an adequate tumor clinic record.

1. General identification data advantageously assembled on a printed page.
2. Summary sheet, serving as a guide to the remainder of the folio and intended to furnish the essential points in the case record at one glance.
3. Statistical form containing information abstracted from the record and tabulated for the purposes of clinical research.
4. Complete history and record of physical examination at the time of the first visit to the clinic, as exhaustive and personal as those taken in a surgical or medical service.
5. Reports of all roentgen-ray studies with the corresponding plate numbers.
6. Record of all clinical laboratory examinations, especially the Wassermann reaction and hemograms.
7. Reports of the pathological department on tissue sections either from biopsy or operative specimens, or both, with the dates and corresponding slide and specimen numbers.
8. Graphic information including photographs in chronological order, photomicrographs whenever possible and diagrams made to scale of the lesion and the region affected.
9. Social service information.
10. Record of the treatment instituted, whether surgery or radiation or a combination of both.
11. Follow-up records, embracing the progress notes made by members of the medical staff at the patient's periodic visits to the clinic, and entries made on the record by the social worker.
12. Miscellaneous, including the various "release forms" employed at different hospitals.

Two points deserve special emphasis—the need for complete radiation records and the value of good graphic sheets. X-ray and radium treatment sheets must have complete information. They should have a diagram of the part and lesion radiated showing the actual position of radiant foci in addition to a statement of the method and the type of radiation employed, the type of container and its strength, and the filter used, the duration of exposure, the surface dose, and size of the tumor and distance from the skin.

THE USE OF THE NATIONAL NOMENCLATURE

H. B. LOGIE, M.D., New York. While hospital staffs are exhorted to keep adequate records in order that they may be approved, the ultimate purpose of record keeping is not just approval, but the promotion of mutual instruction and self-education. Before the hospital record system can be perfected and attain its proper importance the attitude of the hospital physician in writing case histories must be altered.

The wholesome principle of the *Standard Nomenclature of Diseases* is the point of view illustrated on every page that disease is a process, not a thing. Adherence to this principle preaches in its quiet way

the necessity of determining the course of events which constitute the morbid process. It tends to dignify the process of diagnosing and naming diseases, since names take on a live meaning when they are chosen only after a clear and logical process of clinical thinking. Between the lines of the *Nomenclature* is the constant exhortation to the clinician to define his case completely in clinical terms and the warning is there that the names of the specialities of disease are not diagnoses. Moreover the clinician finds that many of his pet terms are either cloaks for ignorance or merely partial diagnoses and therefore not diagnoses at all. Here, then, is a task for the thinking man and not a disagreeable duty to be relegated to the most immature of the hospital's physicians or even to lay employees. The question two years ago was whether physicians would shirk the added responsibility or would respond to the challenge. The answer can now be given. Diagnoses are so much more comprehensive and complete in many of the hospitals using the *Nomenclature* that were it not for the speed and accuracy of the coding system, record rooms would have difficulty keeping pace with them. Cases are diagnosed more fully and the record of the hospital's experience is kept more faithfully not because of rules and regulations, but because the physicians wish them so. Thus, then, is the foundation upon which the National Conference has come to build that clinical thinking is at the root of all medical practice, diagnostic, therapeutic, and prognostic and that the improvement of any hospital depends in large measure upon how fully its physicians realize that the record of its successes and errors and failures, and of the mark of advancing medicine in its practice must be an open book for those who write its history and those who follow.

The National Conference on Nomenclature of Disease in the beginning contemplated only a nomenclature comprehensive enough to serve as a national standard. It soon learned however that nothing but the most accurate possible classification of diseases would serve as a standard for all, and that the system to be set up must be adaptable to an accurate, complete and readily usable system of record keeping. So far as has been possible, the best medical thought in this country and to some extent in other countries, has been put at the disposal of the Conference. The Conference has been compelled to hew as closely as possible to the line of clinical accuracy. Moreover had it not determined at the outset that the nomenclature was to be clinical and not merely anatomical or physiological, it would have been compelled by the parallelogram of forces to adopt this broader view of disease

coupled with a proficiency in shorthand and typing is preferable. The minimum requirements should be set at 2 years of college training and should include a foreign language, preferably Latin. With this background the student should be not less than 21 years of age. She should be required to present a certificate of good health. The make-up of her character and personality should be studied for a sufficient length of time through observation, and her recommendations examined closely, to ascertain whether she possesses the necessary poise and other essentials. Upon completion of the course the student should be required to pass with credit a comprehensive examination prepared by the Board of Registration of the Association of Record Librarians.

The length of the course should be a period of not less than 6 months, 8 months is preferable. Instructors must be selected with extraordinary care and have at least the same educational background expected of the student coupled of course with the advantages in experience which practical application during a period of service has given. The time of such experience has been set at not less than 5 years of actual hospital work. A person should be endowed with a convincing forcefulness and a dignified earnestness in order to qualify as an instructor for only to the extent to which she possesses such characteristics can she be assured of gaining the confidence and respect of her students.

Hospitals in which the student is to receive training may be divided into two classes. First, those connected with universities which can give the educational background at the same time that the student is being given practical experience. Second, those which without a university connection will give the practical training to the student who is already equipped with the necessary educational qualifications.

Any hospital applying for the privilege of training students should be a general hospital with a capacity of not less than 250 beds. It should have an out-patient department, an accredited interne service, a school of nursing, a social service department, and, most important of all, it must possess all the standard facilities required by the American Hospital Association, the American Medical Association, and the American College of Surgeons. The hospital should charge a reasonable tuition or fee for the training and should not treat the student as an apprentice, but provide her with sufficient closely supervised, practical work to permit the actual application of classroom theory.

Thus, we are endeavoring to establish a new milestone in the progress of our profession, to lift it to the plane its importance justifies, and to create standards which will assure its continued development and expansion as a necessary collateral branch of the medical arts. It is our sincere hope and wish that we find a co-operative tolerant attitude on the part of all our associates, and that through such co-operation our efforts may lead to the favorable results which our sincerity of purpose warrants.

BASIC PRINCIPLES IN THE TRAINING OF RECORD LIBRARIANS

JESSIE N HARNED Rochester New York In addition to suitable personality which is most essential a record librarian must have the proper cultural and educational prerequisites. College training

ORGANIZATION AND MANAGEMENT OF A MEDICAL RECORDS DEPARTMENT IN A SISTERS HOSPITAL

Sister M. PATRICIA, O.S.B. B.S. Duluth. When the Standardization program of the American College of Surgeons began in 1918, a new era opened for all hospitals, and in a special sense, for hospitals under the management of the various religious Sisterhoods. It was with the spirit of their founder that the Sisters set about to comply with the requirements of the College. One of the most difficult requirements to be met was "That accurate and complete records be written for all patients and filed in an accessible manner in the hospital."

A well organized medical records department should have a chart of organization. This includes the board of directors, superintendent, medical staff, medical records librarian assistants, and at times, student librarians. In institutions where student librarians are trained affiliation with some nearby college is necessary. Record librarians should hold membership in the Association of Record Librarians of North America.

The major functions of a records department are to contribute accurate data for the scientific study of disease by the staff and internes, and consequently to improve the care of the sick. In conducting research, records are essential. In the treatment of any given disease the records on that disease show what was done for the patient, the reason why it was done, and whether the method of treatment produced the best results possible. Records also give an analysis of the physicians' work in the hospital which information can be used in making appointments to the hospital staff. Staff meetings and pathological conferences could not be held without making use of records.

In our experience the best location for the records room is in the main line of passage. It should be centrally located because of the contact which the records librarian must have with all departments, especially with the regular and visiting staff. It has been advised to place the department as near the staff room as possible because doctors will be likely to consult the records if they are within easy reach.

An efficient filing system is of importance to the hospital and to its medical work. There should be simplicity of arrangement, reference material should be easily accessible, and the scientific classification must be correct. The storage of records has been a problem in most of our hospitals, because of the difficulty in finding a place where the charts can be conveniently and safely kept. The unit system has been acclaimed the best system of numbering and filing records. In the operation of the unit system a designated person should be available during the night to look up charts of previous hospitalization.

The sooner a record is written after the patient is admitted, the greater its accuracy. The supervision of records should also begin as early as possible. Some hospitals use a check system whereby the charts are inspected daily by the personnel of the

records department, and deficiencies noted on colored tags placed on the chart.

No chart is complete unless a follow-up record of the case after the patient has left the hospital is included. It is not enough to file the record when the patient is discharged; one must follow him up for 1 or 2 years to ascertain if the diagnosis of his illness was correct and the treatment successful.

Finally an efficient records department requires the efforts and interest of the entire hospital personnel.

ROUND TABLE CONFERENCE. PROBLEMS CONCERNED WITH CLINICAL RECORDS WITH SPECIAL DISCUSSION OF USES OF CLINICAL RECORDS

Conducted by ALLAN CRAIG, M.D. Torrington, Connecticut

The most outstanding of the many interesting problems relative to clinical records which were discussed at this conference were the following:

1. The prompt writing of records was unanimously voted as one of the difficulties in almost all hospitals. Several speakers emphasized the uselessness of records long delayed and the dangers of records written after the patient had left the hospital. This brought up the question of how far the hospital might go in enforcing record regulations. One hospital record librarian said that members of the staff had been suspended for carelessness in this respect, but that they had returned with the honest attempt to comply with the regulations.

2. Should nurses be permitted to take case histories? This question naturally brought some division of opinion between the larger and the smaller institutions. It was, however, the consensus that case histories when taken by a nurse do not always reveal the true status of affairs either regarding family history or personal history, these being confidential matters between the physician and the patient. It was the general opinion that nurses should not be permitted to write case histories, and that the only person who should and could get a reliable history would be the physician or his assistant. This discussion brought out the necessity of ethical confidence not only in the writing of case records but also in their handling and in their reviews.

3. The use of case records for purposes of research and investigation was discussed at length. Should the physician be permitted to take the records from the hospital? Some of those present indicated that under special circumstances a physician should be permitted to take the records out of the hospital for the purpose of research or investigation or in order to prepare his cases for Fellowship in the American College of Surgeons or the American College of Physicians. It was the general consensus, however, that the records should not be removed from the hospital for any purpose except on subpoena of the court. It was also the majority view that the hospital should provide a place where physicians on the

staff might review records without taking them out of the institution. The question of whether or not the records department should assist physicians and surgeons in preparing their records for the College of Physicians and College of Surgeons was discussed and it was decided that every assistance possible should be rendered these men, and that the records should be typewritten. However the physician should make some arrangement with the records department of the hospital for carrying out this particular work.

4 The permission of one physician to review the records of another was discussed. It was thought by some that the physician should obtain not only the permission of the physician who wrote the record but also the permission of the patient. In reviewing cases for the compilation of statistics or medical or surgical papers, it was felt that this would handicap the physician writing the paper and if the name of the patient were not revealed, the consent of the physician would be sufficient.

OBSTETRICAL DEPARTMENT IN A GENERAL HOSPITAL

CHARLES J. KICKHAM M.D. Boston The maternity department in St. Elizabeth's Hospital is segregated on one floor which contains wards and nurseries, as well as delivery admission, and isolation rooms. None but a maternity patient is ever admitted to this department even though the maternity beds may be in great part unoccupied and though other departments are turning away patients for lack of available space.

Our obstetrical staff consists of a chief, three senior and three junior obstetricians, and a house interne who while on obstetrical service is not permitted to attend any other type of patient. The house patients from the prenatal clinic comprise a large number of the admissions, but any member of the hospital staff may send patients for delivery thus the actual care and delivery of cases in our obstetrical department are distributed among a fairly large group of men.

Upon admission patients are sent to the admitting room. If they are prenatal cases their record is sent up from the clinic. Complications, such as kidney or cardiac disease, are given special attention, but if no complications are noted our routine is to keep these patients in the waiting room during their labor period. Here a general physical examination is made and recorded on admission. The nurse records blood pressure, pulse, duration and interval of labor pains, rupture or non rupture of membranes, any bleeding or abnormal vaginal discharge, action of the fetal heart, and effects of any pre-delivery sedatives which have been ordered. Particular attention is paid to the fetal heart, record of which is taken as a routine every half hour or hour depending upon the stage of labor. Rectal examinations are made on admission and at intervals as indicated and findings recorded. No vaginal examinations are made except upon special order.

Shortly after admission the patient is shaved and scrubbed, and an enema given unless contra indicated for any reason. As termination of labor approaches, the patient is brought to the delivery room and delivered under strictly aseptic conditions. The delivery suite, which includes a waiting room is isolated from wards and corridors.

Nothing but aseptic towels and draperies are used in the waiting and delivery rooms, thus keeping them in a highly aseptic condition. When patients are nursing babies they are obliged to use masks so as to prevent transmission of respiratory infection from mother to baby. Patients after being transferred to the wards are given instructions about danger of infection, and are cautioned about handling or contaminating the parts or carrying infection from below to nipples and breast by the fingers. Routine care is given to vaginal and rectal section especially after bowel movements. Vulva pads are used but left loose so as not to back up lochia. The breasts are watched with care, particularly the nipples, for cracks and between nursings are covered with sterile waxed paper as a result of this constant watchfulness we are happy to report that for many years we have not had a breast abscess. We use the rotating nursery method, and all maternal such as crib coverings, babies clothing etc. is changed frequently and nothing but sterile linen used. If any patient runs a temperature of more than 99.8 degrees for more than 48 hours, she is automatically transferred to the isolation ward. We have been fortunate in having no sepsis for some years, and our mortality rate is very low. As another safeguard, visitors are scrutinized as much as possible, and if observed to have any infection such as a cough or to be using a handkerchief for coryza, the dangers are explained and they are asked not to visit. At no time are children allowed to visit.

All nurses are watched for any type of infection. Nurses and internes in the obstetrical delivery room are those who have already had their operating room training. During the training year all nurses are given special courses by the staff on obstetrical and gynecological subjects.

CARE OF EMERGENCIES

CORNELIUS J. O'LEARY M.D. Boston Being situated in a district through which some of the main arteries of travel pass into the city and being within easy range of a number of small industrial plants, St. Elizabeth's Hospital has a busy accident department. We are prepared to handle accidents during all hours of the day or night. The department is in charge of one of the Sisters who is a trained nurse. To assist her she always has one or more of the student nurses.

When the accident case arrives the patient is taken at once into a room immediately adjoining the admittance door. The house officer whose sole work during a period of 3 months is to handle accident cases, is summoned at once. We have a rotating system for our internes at the hospital, and they

take charge of the accident service only after completing all their other services, the interne in charge of this department is always well trained.

If the accident is slight the interne himself cares for it—always, however, giving orders for the patient's return on the following morning at which time the visiting surgeon sees him and approves what the interne has done or institutes such other treatment as may be necessary.

If the accident is severe the visiting house surgeon is summoned at once. The arrangement at our hospital is for 6 surgeons to take 2 months each on house cases. During the time of their house service they are also on service for serious accidents. When the surgeon has viewed the patient he admits him to the hospital if he believes such procedure necessary. Fracture cases, if severe are referred to the orthopedic department.

In all cases of severe head injuries patients are X-rayed at once. Regardless of the findings, the patient is advised to remain in the hospital for a period of at least 24 hours. Having specialists in eye, ear, nose and throat work, all of whom are not far from the institution and who are expected to respond at once to any urgent call from the hospital, we are prepared to take care of such cases under the guidance of skillful doctors.

No operative work is done in the accident room nor are blood transfusions given there. Our operating rooms, under 24 hour supervision of graduate nurses, are so near at hand that the patient can be transferred thereto without any loss of time if major operative work is necessary. Everything required for emergency work in such cases as drownings, asphyxiations, monoxide poisonings, and the like, are to be found right at hand in the accident room. With such arrangement and equipment we have no difficulty in successfully treating the large number of emergency cases which we are called upon to handle.

OUT PATIENT DEPARTMENT

REV THOMAS J. BRENNAN, Boston. I have been unable to determine historically the genesis of the out-patient department. Probably someone in the vicinity of a hospital who was in need dropped in and asked if some doctor would see him, which request was very charitably granted. Others, bearing of the service, probably did likewise and soon the hospital saw the desirability of establishing such a service for the needy. This is merely a theoretical explanation.

The organization of the out-patient department at St. Elizabeth's follows along the lines of out-patient departments in general hospitals. More than 17,000 patients were treated in this department during the past year.

To cite an editorial from the current *Medical Digest* which discussed an article entitled "The Plight of the Doctor." It is now customary even in hospitals maintained by public and private con-

tributions, to make small charges for medical service in the so called free clinics. But it has never become customary for the doctor to be paid for his work in these clinics. Once a free patient, always a free patient. Doctors have observed that they rarely ever are visited again by a patient after that patient has acquired the free clinic habit. Most of those who first entered free clinics because of the economic depression never again will patronize their family doctor.

It is the duty of the hospital to protect the doctor from unworthy cases—those who dishonestly abuse the service of the free clinic. While good social service departments can do much in this matter there are always hidden resources which even these departments cannot investigate. Would it not then be a good idea to make each patient coming to the free clinic bring a letter from a local physician stating that the case is a worthy one? In this way the physician would at least have an opportunity to offer free care to the patient, and he may even be remunerated at a much later date. Under present arrangements he is denied this opportunity.

MATERNAL CARE

A series of practical demonstrations on maternal care, supplemented by motion pictures, was conducted at the Boston Lying In Hospital by LOUISE S. ZUTTER, R.N., superintendent, and heads of departments. The program embraced the following features:

"Admission of Patient to Clinic," ERMINE COMEA, R.N. "Physical Examination of Patient," HAROLD M. TEEL, M.D. "Care of Patient in Labor," Care of Patient in Delivery Room, Immediate Post Partum Care," ETHEL STEWART, R.N. and assistants, "Care of Newborn, Formula Room," BERNICE DENIORD, R.N. "Care of Premature Infant," DOROTHY SOLOMON, R.N. "Care of Post Partum Patient," EDITH CARPENTER, R.N. "Care of Isolated or Septic Patient," FLORENCE BOSTOCK, R.N. "Post Partum Clinic," FLORENCE SWANSON, R.N.

A round table conference was conducted by ROBERT JOLLY, Houston, superintendent, Memorial Hospital, and president, American Hospital Association, on "Administration, Professional, and Economic Problems," which constituted a clearing house for all questions arising out of the deliberations of the previous sessions, in addition to a special program of fifty important hospital questions.

Demonstrations and round table discussions in hospital standardization and administration were conducted at the Beth Israel Hospital by CHARLES F. WILKINSKY, M.D., director and heads of departments, including the following: The Training of Internes in the Social Aspects of Illness," ERMINE COMEA "Food of Hospital Patients," MARGARET MOORE "Some Nursing Problems in a General Hospital," JOSEPHINE A. MULVILLE, R.N. "Applications of Business Principles in the Management of Hospitals," CHARLES F. WILKINSKY, M.D.

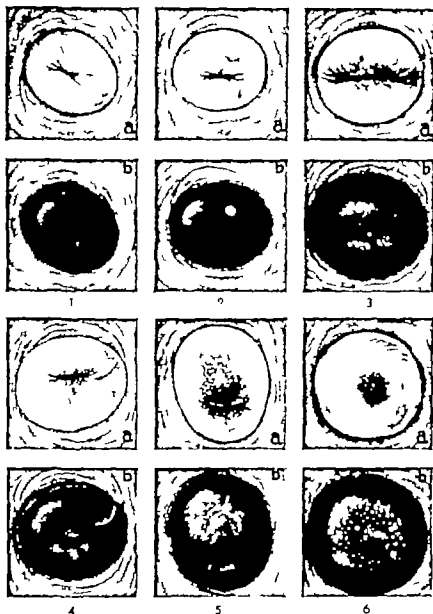


PLATE I Lohm-Schiller test a Before the application of Lugol's solution b after the application These reproductions were drawn at the time of the test and the colors carefully checked

1. Normal cervix
2. Multiparous cervix with a nabothian-like follicle (See Figs. 17 and 8)
3. Lacerated cervix with early carcinoma on the posterior lip (See Figs. 14, 15, and 6)
4. Multiparous cervix with small ring of erosion and prominent scar
5. Multiparous cervix with marked hypertrophy of the anterior lip and erosion with some eversion
6. Multiparous cervix with diffuse spotting of leucoplakic plaques and eversion

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PRECANCEROUS AND CARCINOID LESIONS OF THE CERVIX UTERI

WITH COMMENTS ON THE SCHILLER TEST

ERLE HENRIKSEN M.D. BALTIMORE, MARYLAND

From the Gynecological Department of the Johns Hopkins Hospital and University

IN the great majority of cases the diagnosis of carcinoma is simple enough either clinically or pathologically and microscopic examination is only confirmatory. In the early and "borderline" cases however, the microscope must play the decisive rôle. To wage an effective fight against cancer, moreover, we must not only be familiar with the characteristics of early cancer but we must learn something more about lesions now loosely spoken of as "precancerous." This term was first used by Dubreuilh in 1896 and has been widely adopted. It is undoubtedly a good descriptive term if applied as it should be, only to those processes which may but do not necessarily, become malignant. It should not be construed as indicating that the lesion in question represents the preliminary stages of cancer, though it is quite possible that some of them do. As long as we do not know the cause of cancer a study of these lesions and of their possibly malignant potentialities offers a new and fertile field for the gynecological pathologist and may be expected to yield much in the way of early treatment and prophylaxis of cancer.

We have recently completed a study of material from the cervixes of 50 individuals who have been treated conservatively in our department, in an endeavor to correlate as accurately as possible the histological picture and the subsequent clinical course. Micro-

scopically the cervixes all showed evidence of increased cellular activity i.e., mitoses, hyperchromatosis, polymorphia, and hyperplasia of the basal layer, without, however, any evidence of invasion. Indeed all the cytological characteristics of cancer were in evidence except epithelial heterotopia. Recent examinations have shown in spite of the cancer like cell changes in the original lesions, no tendency to the subsequent development of cancer.

Normal cervix. The accepted description of the normal histological picture of the cervix varies so markedly that it is difficult to obtain sections of the epithelium conforming to the textbook descriptions. The distinction between the three accepted strata is definite. The basal layer has a picket fence appearance with an undisturbed nuclear polarity. Mitoses and hyperchromatosis are more frequently present than most observers have noted but these are merely suggestive of expected natural cellular changes necessary for the processes of growth and repair.

The thickness of the epithelial layer is apparently independent of the age of the adult patient and we have noticed no constant histological changes in the pregnant cervix. Inflammatory processes seem to alter the basal layer bringing about an apparently increased cellular activity. Hot douches, cauterizations, and local therapy also produce a distorted histological picture (Fig. 2).

Metaplasia The value of serial sections of biopsy material is fully demonstrated in cases of so called metaplasia or epidermization. Though in some instances the cytological changes resulting from the inflammatory lesions do present a perplexing picture the cellular activity in some of the chronically infected cervixes has frequently led to erroneous interpretations, and probably accounts for some so called 5 year cures. In most instances the benign invasion by the squamous epithelium is innocuous in appearance and in no way resembles the ruthless invasion of the malignant growth. Cell nests and columns of squamous cells (Fig 3) apparently lying free of surface attachment may tend to confuse the picture. A full appreciation of the mechanism of this process simplifies its interpretation and lessens the probability of errors in diagnosis. The individual cells in most instances display none of the characteristic cytological features associated with malignancy. The round cell infiltration is also less marked though this reaction is far from dependable. Mitoses and hyperchromatosis are not uncommon and not infrequently the changes are so marked as to suggest a cancerous process.

That in the majority of cases so called metaplasia is not a precursor of cancer is accepted. However the presence of this process does imply a chronic irritation and conservative corrective therapy is indicated. Without

doubt a few of these lesions do develop into malignant processes, but it is not possible with our present information to differentiate the ones that will remain benign from those possessing malignant potentialities.

Leucoplacia Hinselmann's work with the colposcope has revived our interest in the leucoplacia like changes in the cervical epithelium and has also created a new field for possible diagnostic errors. Simple curetting of the cervix for microscopical study as originally suggested by Schiller does not yield sufficient tissue for the diagnosis of this process, as the individual cellular changes may too closely simulate the cells of cancer. Again the value of serial sectioning of biopsy specimen is to be emphasized.

The process develops most frequently at the site of transition between the squamous and columnar epithelium though it is not rare to find the entire cervix sprinkled (Plate I, Fig 6) with the small white or grayish white plaques. Microscopically the epithelium is more compact and varies in thickness. There is decided basal layer hyperplasia with changes in the nuclear polarity. Mitoses may be of both the normal and the pathological types, though they may be very sparse. The subepithelial round cell response also varies and may at times be entirely lacking. We have not noticed the subepithelial hyalinization which is so commonly seen in leucoplacic processes elsewhere. In those cases with marked stromal reaction it is frequently difficult to trace the basal line and the presence of invasive tendencies may be simulated. As Schiller has shown there is usually a sharp transition from the normal epithelium to the area of leucoplacia. This line of demarcation is also prominent in other conditions as we shall describe later. Leucoplacia elsewhere is considered genuinely a precancerous lesion, but whether this applies to the cervix is certainly debatable. The histological criterion accepted by some include changes characteristic of definite malignancy except that invasion is not present. Several observers claim to have observed cases in which cancer has developed within an area previously shown to be leucoplacic. We have not been fortunate enough to encounter any similar instances.



Fig 1 From a 19 year old nullipara (Plate I, Fig 1). The three strata are well defined and the basal line is intact with equal nuclear polarity. No stromal reaction.



Fig. 2

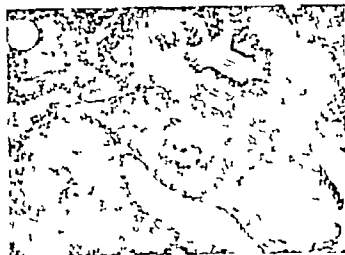


Fig. 3



Fig. 4

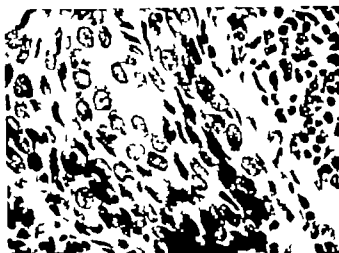


Fig. 5

Fig. 2 An unusual abrupt change between the loosely packed squamous layer on one side and a more compact layer; this differs from the transitional line in certain other conditions in that it is vertical. This patient had received a prolonged course of local therapy to the cervix.

Fig. 3 Benign epidermization with nests of squamous cells, rare mitoses, and no suggestion of malignancy.

Fig. 4 The epidermization process has replaced the cylindrical elements in an orderly fashion, except at one point there is an apparent break in the basal membrane.

Fig. 5 High power of Figure 4 showing increased cellular activity with mitoses, many hyperchromatic nuclei, and no definite limiting layer. Six years after this biopsy was taken the patient shows no evidence of cancer.

However we do believe that the present evidence is insufficient to place this lesion in the same class, as regards cancer potentiality with the leucoplaciac found elsewhere.

Carcinoma Whether or not the metaplastic and leucoplaciac processes of the cervix are likely to develop into true cancer is undecided. And yet we do not feel justified in permitting certain lesions to remain untreated because of scientific interest in their future course. The following case shows that carcinoma, here a basal cell type may develop in metaplastic area.

The cervix (Plate I Fig. 3) was deeply lacerated with a duck bill appearance three

small plaques were present just within what was formerly the external os. Following the application of the iodine solution the two plaques on the anterior lip showed some absorption of the iodine and microscopically a local epithelial hypertrophy. The small plaque on the posterior lip, however did not absorb the iodine and stood out sharply against the mahogany background. Biopsy was not performed as an interposition operation with cervical amputation was indicated. Serial sections through the posterior lip showed a small malignant growth measuring 1 millimeter in diameter and originating in an area



Fig 6 Changes in the cervical canal depicting the columnar elements replaced by squamous cells. Beneath the pale, normal appearing cells is noted the increasingly broad layer of darker stained cells, this layer supplants the paler cells entirely and assumes an appearance suggesting cancerous activity

of definite metaplasia. This patient is being examined each month and as yet has shown no tendency to recurrence.

Other interesting cervical lesions. So far as we know the microscopical cervical changes in the 2 following cases have received little or no attention in the literature. In 1912 Bowen described similar changes in the skin in an article titled "Precancerous Dermatoses. Chronic Atypical Epithelial Proliferation" and the skin lesion described is accepted by most dermatologists as Bowen's disease. The



Fig 7 High power showing the marked cellular changes. Mitoses and hyperchromatosis are frequent. This patient shows no evidence of cancer after a period of 18 months has elapsed

acceptance of this as a nosological entity from the standpoint of etiology and pathogenesis is still debated as is its relationship to the so called extramammary Paget's disease. Though the histological changes in our cases do not altogether fulfill the cytological criteria specified by Bowen, Darier, Jessner and others, the similarity is striking enough to bear comparison.

CASE 1 (Plate I Fig 2) In October 1933 a 24 year old negroess was examined for vaginal bleeding, later found to be the result of endometrial hyperplasia. Inspection of the cervix revealed a small cyst like area on the anterior lip suggestive of an



Fig 8 Biopsy from a cervix of a 45 year old woman with prodisentia of 2 years standing. Marked thickening of the squamous layer with metaplasia. The basal layer shows definite hyperplasia, increased compactness of the strata, and increased cellular activity with abundant stromal infiltration

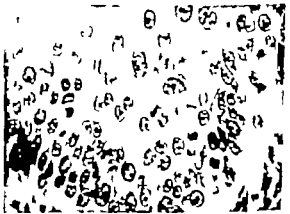


Fig 9 Higher power showing typical mitoses with polymorphism and hyperchromatosis. The cervix was excised following an interposition operation and 4 years after this operation had been performed there is no change present which might be regarded as suggestive of cancer



Fig. 10 A specimen removed from the anterior lip of the cervix in 1930. There is no evidence of cancer on recent examination. This is definitely of the leucoplastic group, showing epidermal thickening, increased compactness of the basal and transitional layers. Several small epidermal buds seemingly lying free of surface attachments are the result of angular sectioning. There is no evidence of invasion.

ordinary nabothian cyst. However, the iodine was not absorbed as readily as expected and the biopsy showed changes suggesting early malignancy with perplexing cellular changes. Radical measures were deemed unnecessary as it was thought that the entire growth was included in the biopsy. The location of the area was also considered to speak against malignant growth as the accepted site of predilection for both cancer and leucoplacia is near the external os or at the junction of the squamous and columnar cell layers.

This case is being carefully watched in our outpatient department and at a recent examination shows no recurrence of the white areas and the cervix has always readily absorbed the iodine.



Fig. 12 Section of a polyp removed in 1930 showing marked basal hyperplasia with all the cellular changes characteristic of cancer. However invasion has not taken place.



Fig. 11 High power of the epidermal bud shows many mitotic figures; however the entire picture is that of a benign process with increased cellular activity.

CASE 2 There is no evidence of invasion in either of these cases. The relative lack of stromal reaction, with the edema and hyalinization in the second case removes this lesion from the category of accepted cancer. The true nature of this lesion is not known: are we dealing with an unusual form of cancer or of leucoplacia or a pro-cancer with a new pathological and clinical entity? Two cases are not enough to warrant conclusions as to their true etiology or pathogenesis. We are following with interest the first case which was treated conservatively but unfortunately a panhysterectomy was performed on the second case.

Intracervical carcinoma Though not an instance of early malignancy, we have included the following case not only to illustrate the value of the Schiller test in some cases but

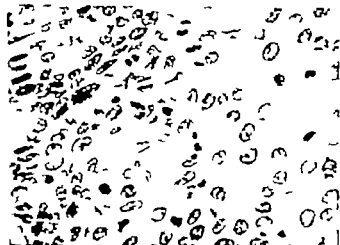


Fig. 13 High power showing both normal and pathological mitoses. There is also a moderate polymorphism. The stromal reaction is not marked. The patient on recent examination shows no tendency to cervical cancer.

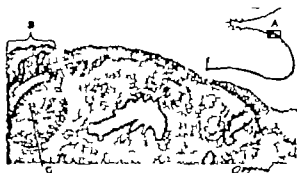


Fig. 14. The line of transition between the squamous cells in the more normal epithelium and the carcinoma area is sharp and clearly demonstrates the mode of malignant extension.

also because of the unusual nature of the malignant extension.

CASE EL. A 60 year old negroes was registered with the complaint of vaginal bleeding of 3 weeks duration. At examination there was no apparent bleeding and the pelvis was essentially of the normal senile type. On inspection the cervix was found to be smooth and firm with a wide velvet red margin about the external os, which did not bleed following manipulation. This was interpreted as a typical erosion. A cotton swab passed up into the cervical canal did not elicit bleeding. Following the application of the iodine solution a small grayish-white plaque about 3 millimeters in diameter was noted at the right lower angle. A biopsy specimen showed a slight thickening of the epithelial layer with a small area sharply demarcated from the more



Fig. 15. Higher power drawing of B in Figure 14 showing more clearly the cellular differences between the two areas.

normal appearing tissue and strongly suggestive of leucoplakia. One small nest of squamous cells, however made us suspicious of malignancy though various observers differed and some considered it benign. In view of the patient's history of post-menopausal bleeding, age, and the suggestive microscopical picture, a panhysterectomy was advised.

LAHM SCHILLER TEST

It was noted by Lahm in 1927 that the portio vaginalis of the cervix displayed certain absorptive qualities following the application of Lugol's iodine solution. The chemical basis for this absorptive ability has been attributed to the presence of a glycogen-like substance in the cells of the spinal layer of the cervical epithelium. The clinical value of the test was further elaborated by Schiller following a thorough study of different lesions and their reactions. However the correct interpretation of the test is not a matter of simplicity as there are many modifying factors present even in the normal cervix and many that may serve to confuse the final picture.

In the crowded out patient department the application of the iodine solution with a sponge is not only time consuming but exceedingly inconvenient. To overcome this disadvantage we use a bulb atomizer with the cervix well exposed and clean. It is relatively simple to spray the entire cervix under direct vision. The excess solution is removed with the speculum following the examination.



Fig. 16. High power drawing of C in Figure 14. Gland cells are also present, but are more numerous in the surface area. This is the earliest definite carcinoma of the cervix we have seen, and is of special interest in that it appears in an area of metaplasia commonly regarded as benign.



Fig. 17 An oval epidermal bud with marked karyokinetic asymmetrical division, peculiar clumping of the nuclei, and vacuolization of the cells. There is a moderate parakeratosis, with nuclei broken up into very small granules. A few large cells with numerous large nuclear fragments can be seen scattered through the entire epithelial surface. The picture is suggestive of those changes associated with arsenical keratosis and is not dissimilar to roentgen-ray dermatitis

Previous digital examination with an oiled or soaped glove will tend to confuse the picture. When the cervix is covered with blood or discharge spraying the cervix with a moderately strong solution of potassium permanganate and carefully wiping with a soft wet sponge is sufficient to ensure a clean surface. Care must be exercised in manipulation so as not to traumatize the cervical epithelium thus removing the glycogen-containing cells and distorting the picture.

The normal surface of the pars vaginalis absorbs the iodine evenly and assumes a dark mahogany color. Nabothian follicles as a rule also absorb readily, but not infrequently stain to a lesser extent. In case of eversion with the columnar epithelium presenting the stain is not absorbed by the everted mucosa and the color is a pinkish red (Plate I Fig. 6). This is disappointing as the test is thus of no value in cases of adenocarcinoma. However this type of growth is relatively infrequent occurring only in 1 of 25 cases in our series.

The areas of erosion vary in relation to the intensity of the inflammatory reaction (Plate I Fig. 5). The more acute the inflammatory process the deeper the absorption, as the leucocytes rich in glycogen readily take up the iodine.



Fig. 18 High power showing the definite intracellular oedema and hyalinization, parakeratosis, hyperkeratosis, multinucleated giant cells with clumped nuclei, and a few pathological mitoses. There is no evidence of an invasive tendency and the cells are for the most part embryonal in character

We have recently noticed certain variations in the pregnant cervix. In three young primigravidae in the early months of pregnancy, and with cervixes normal in appearance the iodine was absorbed readily in two instances and taken up very lightly in the third. This was repeated a number of times with the same result each time. Biopsy failed to reveal any histological clue for this variability. We have also noted in apparently normal cervixes following supravaginal hysterectomies that some of the cervixes fail to absorb as readily as before the operation.

As a rule the areas of metaplasia do absorb the iodine as do cases of advanced malignancy in which there is a marked secondary infection. With late cases having suspicious nodules in the vaginal vault, the application

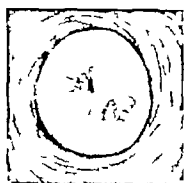


Fig. 19 Small grayish-white elevated plaque not unlike the preceding case in location and gross appearance. The pitted area is the site of the biopsy

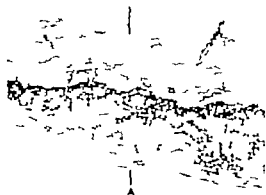


Fig. 20. The biopsy specimen showing an edematous subepithelial layer with hyalinization, which is not uncommon in leucoplakia elsewhere in the body, also a scant round cell reaction. The transition between the obviously normal epithelium and the abnormal area is not as marked in this drawing as in Figure 22, but the transition in the stroma is surprisingly sharp, and extends through the entire area of the process.

of the iodine may serve to outline the areas of malignant extension.

Leucoplakic areas are occasionally visible without the aid of the iodine test as small white or grayish white plaques. But these vary from day to day in their gross appearance and whether this chameleon like ability affects the absorptive power is not known. However we have observed several cases in which the histological picture was that of typical leuco-



Fig. 21. High power view from the center of the process illustrating the peculiarly large giant-like cells with pathological appearing mitotic figures, the intracellular edema and keratinization. The latter is more apparent in Figure 23. There are also a few abnormal mitoses. The intracellular edema alone differentiates this process from extramammary Paget's disease, where intercellular edema is present with the large characteristic Paget cells.

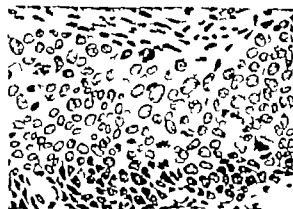


Fig. 22. High power view from the center of the process illustrating the peculiarly large giant-like cells with pathological appearing mitotic figures, the intracellular edema and keratinization. The latter is more apparent in Figure 23. There are also a few abnormal mitoses. The intracellular edema alone differentiates this process from extramammary Paget's disease, where intercellular edema is present with the large characteristic Paget cells.

plakia, while the gross picture even with the aid of the iodine was negative.

Small areas of carcinoma of the squamous cell type present a picture identical with that of leucoplakia, so that the test is not specific for malignancy but serves rather as an aid in selecting the site for biopsy.

Though this test is routinely applied to every patient in our dispensary and fully 25 per cent of the cases have been checked histologically, we do not at all feel that it is infallible. The use of the colposcope as advised by Hinselmann and others does magnify the gross picture but with good exposure and



Fig. 23. Higher power to illustrate the intracellular edema and keratinization, which is especially marked in this case.



Fig. 24 Normal appearing senile cervix with typical erosion about the external os the biopsy site at the lower right angle. On gross examination of the cervix after the removal of the specimen there was no suggestion of cancer

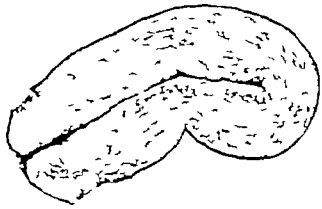


Fig. 25 Longitudinal section through the uterus, showing a definite well circumscribed intracervical carcinoma with the canal relatively free of the usual friable projections commonly present in malignancies of the cervix. Extending from the primary growth in the cervix is a thin layer of cancer of the squamous cell type which covers the entire endometrial surface but does not extend out into the tubes.

light the added cumbersome and expensive equipment is not indispensable. We have picked up several early cases of true carcinoma which undoubtedly would have been missed without the aid of the test. An advantage of the test is the simplicity of its application especially with the aid of the atomizer. The test also necessitates a thorough study of the cervix with good exposure and light a point in pelvic examination frequently overlooked. It is the only subsidiary diagnostic aid we have at present and warrants a thorough and fair trial.

BIOPSIES

In view of the admitted difficulties in the microscopical diagnosis of early carcinoma of the cervix the amount of tissue for study must be sufficient to include not only the suspected area but also some of the apparently normal tissue. For satisfactory interpretation of the histological picture an aggregate view of the changes must be obtained. Diagnosis based on the individual cellular changes is hazardous especially when the tissue is scant in amount. One section from the area in doubt frequently misses the suspected process while serial sections of the specimen will not uncommonly reveal the real nature of the lesion. We have been impressed with this on many occasions and routinely follow this procedure.

The dangers of infection dissemination or stimulation of the tumor growth and hemorrhages are apparently not as dangerous as they were once considered by many. In spite of any possible risks the data obtained more than counterbalances them. That stimulation of

the tumor growth occurs is a moot point there is no proof that the growth is accelerated and animal experiments show no change in the growth rate following trauma. Neither have we noted any infections following the biopsy either with the punch forceps or with the scalpel. Three days after taking a biopsy from a normal cervix the wound is usually completely healed. In most cases the site of biopsy is touched with phenol or silver nitrate. Hemorrhage except in advanced cases rarely occurs and at most amounts to only a slight



Fig. 26 Low power drawing showing the relation of the squamous cell cancer spreading like "cake frosting" (cancer of the "zuckerguss" type) over the entire endometrial surface the endometrial glands are of the senile type. The growth has not invaded the myometrium

venous ooze. An important factor in taking the biopsy is immediate fixation for it has been shown that the alkaline secretions of the cervix bring about a definite fading of the nuclear particles and thus the resultant microscopical picture is hazy. Immediate freezing and staining is the ideal method but when permanent serial sections are desired from a small bit of tissue this procedure is difficult and undependable except in the hands of an expert.

The divergence of opinion as to the diagnosis in very early carcinoma of the cervix is disheartening many still seem to cling to the older concepts of cellular confusion so characteristic of the late stages. At the other extreme are those who scent malignancy wherever there is a departure from the accepted normal of cellular activity. In order to appreciate fully the pathology of the cervix one must be especially equipped to diagnose the very early case. To attain this knowledge one must possess a familiarity with all the various cellular changes checked by careful follow up studies in each case. Merely to call the changes suspicious or doubtfully malignant is of little aid to the clinician who wishes to be informed that the lesion is either benign or malignant. If the pathologist can not decide either way the responsibility reverts to the clinician though when such doubt exists the wise plan is often to defer active treatment until the question can be definitely settled for such a slight delay will rarely endanger the patient.

SUMMARY AND CONCLUSIONS

The microscopic diagnosis of cervical cancer will not be improved until both the clinician and the pathologist learn more about such pseudomalignant and possible pre-malignant lesions of the cervix as have been discussed.

Mitotic figures are occasionally seen in the basal layer of the normal cervical epithelium and are to be looked upon as evidence of the normal growth and repair of the cervix.

Cervical lesions may be spoken of as "pre-cancerous" when it is understood that the term implies they might though not necessarily become cancerous. The microscopical picture of these lesions is less perplexing if the mechanism of development is understood. That cancer does originate in the so called metaplasias is illustrated by 1 case.

Leucoplakia of the cervix is a pathological entity which may show cellular changes suggestive of cancer though invasion is always lacking.

Two cases showing microscopical changes similar to both Bowen's disease and extra mammary Paget's disease a condition rarely if ever described in the cervix.

An interesting case is described of intra cervical carcinoma diagnosed with the aid of the Schiller test, and in which the malignant growth extended over the entire endometrial surface of the uterus.

The importance of biopsy is indisputable but its value is increased if the specimen is immediately fixed and serial sections are made. Serial sections are of especial importance in cases of suspected early cancer.

The application of Lugol's solution with the atomizer simplifies the test. The Schiller test is undoubtedly of some value in the diagnosis of early cancer whether it is a specific for the absence of the cancer is questionable.

To Dr. Thomas S. Cullen and Dr. Emil Novak we acknowledge with sincerest gratitude our indebtedness for the valuable assistance in the preparation of this paper. We also wish to express our gratitude to Mr. Milton Koenig for the splendid photomicrographs, to Mr. Leon Schlosberg for the colored plate, and to Mr. M. D. Dietrich and Mr. J. O. Osgood for the drawings.

BIBLIOGRAPHY

1. BOWEN, J. T. Precancerous dermatoses: a study of two atypical cases of chronic atypical epithelial proliferation. *J. Cutan. Dis.* 1912, 30: 24.
2. DUNN, J. La dermatose precancerieuse de Bowen. *Ann. de dermat. et Syph.*, 10 4. 9 5 5: 440.
3. HENSELMANN, H. Zur Kenntnis der precancerösen Veränderungen der Portio. *Zentralbl. f. Gynäk.* 1927, 51: 901.
4. SCHILLER, W. Early diagnosis of carcinoma of the cervix. *Surg. Gynec. & Obst.* 1933, 56: 210.

FULMINANT SINUS DISEASE

STUDY OF THE PATHOGENESIS¹

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THE nose with its accessory nasal sinuses is capable of giving rise to interesting and formidable pictures indicative of local and general disease. Acute osteomyelitis of the maxilla, especially in infants occurs with sufficient frequency to lead to considerable theorizing as to its etiology and therapy. In studying the complicating factors and sequelae of this condition we have tried to trace the ways by which it becomes associated with acute suppuration of the accessory sinuses of the nose.

The literature is replete with case reports of fulminant nasal sinus involvement, in these the various complications, the possible etiological factors, and the treatment applicable in each instance are discussed. The majority of reports name thrombophlebitis as the usual route of extension and stress conservatism in treatment. The autopsy material has been surprisingly meager, clinical evidence or biopsy specimens were usually taken as final. We were fortunately able to study serially sections made through the head of an infant 3 weeks of age who as the history indicates developed a fulminating sinus infection manifested by external swellings about the face and associated with a concealed thrombus in the cavernous sinus. Even without the history, a careful study of the histological series would make it quite possible to trace in chronological order the entire course of the disease.

CLINICOPATHOLOGICAL FEATURES
OF FULMINANT SINUS DISEASE

Fulminating sinus disease always has been considered a formidable condition because of the anatomical relationship between the sinuses and the surrounding structures. Endocranial, auricular, ocular, dental, and systemic involvement may result from extension of sinus infections. In speaking of a fulminating type of sinus infection, the writer refers to sinus disease which manifests itself by swellings about the face, osseous involvement, and

intracranial signs and symptoms, other authors prefer to look upon this type as merely acute sinusitis. Yet the spread of infection by direct extension (continuity of structure), or through the lymphatics or the blood stream and along the facial planes, foramina, and perineural sheaths is well recognized, the pathological alterations which occur depend upon the special anatomy of the region.

The subject is of sufficient importance to note briefly the several possible pathways by which an infection in the sinuses of the nose may involve other structures. Since the particular type of sinus disease under consideration occurs so frequently in infants and young children certain anatomical and developmental features demand special consideration. Aside from traumatic possibilities, infections may invade the cranium through congenital dehiscences—the ethmoidmaxillary suture or openings in the bony wall of the lamina papyracea or in the orbital wall of the maxilla. That infection can travel by way of the perineural sheaths requires some explanation. It is not generally known apparently, that there is no direct connection between the lymphatic vessels of the peripheral parts and the intradural structures and that the sheaths surrounding the olfactory nerves although they are continuous with the piaarachnoid, do not contain lymph. Spread by lymphatics has heretofore been thought to be the common method of extension but the anatomical facts suggest otherwise (18).

Direct invasion of the vessel wall by way of communicating veins is probably the commonest mode of extension. The nose is particularly rich in venous drainage. The septic thrombus proceeding by way of the diploic veins may produce a retrograde infective thrombophlebitis or periphlebitis. Involvement of the cavernous sinus may occur through various venous routes according to which areas of the nose and its surroundings are diseased. Foci in the anterior part of the

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Fig. 1. Characteristic external findings of edema of the lids, one in an infant and the other in a 9 year old. Both responded to conservative therapy. These cases represent the experience usually encountered.

nose may extend to the sinus by way of the angular vein, whereas those in the interior of the nose and sinuses go through the ethmoidal veins. Such a case from my clinic was recently reported. In this instance a bilateral cavernous sinus thrombosis developed following a submucous resection of the nasal septum (7). Infected foci in the superior maxilla may spread by way of the pterygoid plexus. The anastomotic venous radicles also permit infection to be transmitted between these different channels. Caries and inflammatory erosion of bone (osteoclasia) may result from extreme pressure by inflammatory products or these products may cause a separation of the bone from its mucous membrane and mucoperiosteum.

Purulent inflammation of the nose especially during influenza or any of the acute infectious fevers, may cause a reaction of the tissue which interferes with the normal ventilation of the sinuses. There may be anatomical obstructions or there may be swollen turbinates impinging upon the septum even though the nose gives little evidence of inflammation shows no bulging of the wall of the nasal cavity and maintains a free flow of secretion. Usually it is the ethmoid sinuses that are involved although a pansinusitis on the same side may occur. The ethmoid cells are well developed early in childhood and since acute upper respiratory tract infections are frequent, involvement of these sinuses is by no means rare. In addition the vascular

and lymphatic development is greater in children than in adults (3). The mucosa becomes edematous and the underlying periosteum becomes infiltrated (periosteitis); the bone bleeds freely (osteitis) during operative intervention. The structures overlying or neighboring the bone may become swollen and the bone itself become sequestered (caries).

CLINICAL PICTURE

A unilateral swelling of the upper lid is characteristic of frontal involvement (in children past the age of 5 years) a swollen lower lid is associated with ethmoid cell disease or both lids may be swollen in a combined involvement (Fig. 1). The lids become infiltrated (periocular and orbital cellulitis) and occasionally the infection may localize and form an abscess (orbital abscess—Fig. 2) or even break down to form a fistula (caries or necrosis—Fig. 3). Similar swellings, at first brawny and later soft may occur over the frontal area and the cheek. Inflammation usually causes a thickening of the periosteum at the medial wall of the orbit leading to a red painful swelling near the inner canthus of the eye. There may also be pain localized to the involved area or referred to other parts of the head. The temperature may vary from 98 to 105 degrees F. Strangely enough, one may find a violent external manifestation in an individual who is not acutely ill. Figure 4 shows a rather striking picture of objective inflammatory reaction, without much sub-



Fig. 2. left. An abscess of the lid which resulted from a periorbital cellulitis. This condition necessitated external drainage in addition to shrinkage and intranasal drainage.

Fig. 3. In this patient, as the result of a caries with abscess formation a fistula from the floor of the frontal sinus occurred. An external approach, with the removal of sequestrated bone when the acute process subsided, led to a resolution of the process.



Fig. 4. A striking picture is presented by such a marked objective reaction, as shown in this case, without much subjective response. In this patient the appearance was even more exaggerated because of the application of tincture of iodine to the forehead by the patient himself. The therapy in this instance, infraction of the middle turbinate and irrigation of the frontal sinus, favorably influenced the picture within 48 hours.

jective response. The eyeball itself may remain normal but occasionally becomes proptosed; the bulbar and palpebral conjunctivae are decidedly chemotic. Motion of the eye may be limited owing to external rectus paresis or impaired motility of the extra-ocular muscles. When the proptosis becomes so great as to prevent the lids from covering the eye, corneal ulcers may form. A papilloedema may also occur in such cases. The predilection for the maxilla is explained on the basis of its larger size, more rigid construction, attachment to the skull—favoring a more frequent reception of trauma—and greater blood supply around areas of ossification. Unerupted teeth represent areas of greater vascularity which may determine metastatic infection.

Saeger, reviewing 67 cases of orbital inflammations collected from the literature and one of his own, concluded that sinus disease is one of the most common causes of orbital inflammations in children. He quoted Coakley, Harke, Oppikofer, Wertheim and Wolff as showing by autopsies that the sinuses of children may be readily involved. Others believe that children do not have the essential predisposition for rhinogenic orbital inflammation that adults have. Theisen, in a study of 31 cases from his service in an infants hospital, found the sinuses so commonly af-

fected in orbital complications that confirmation by X ray was not considered necessary. The orbital cellulitis is considered by Babbitt as a secondary manifestation of infection—a syndrome rather than an entity. The cases with early external orbital manifestations are thought by Barwich to run a more benign course than those without external symptoms.

Approximately 75 per cent of orbital infections were secondary to disease of the nasal accessory sinuses, particularly the ethmoids, in a series of 60 cases reported by Porter. Eighty-two per cent of these were in children.



Fig. 5. Child, 3 weeks of age, showing a brawny swelling of the left side of the face. The eyelids are reddened, edematous and almost closed. The edema extended beyond the outer canthus to the temporal area and to the cheek, where the induration was also brawny in character.



Fig. 6. Frontal plane section in the region of the deciduous molar and the respiratory portion of the nose. *A* showing the breaking down of the mucosa below the inferior turbinate as though it had contained an abscess. *B* roof of the mouth in the region of the hard palate and the area occupied by corpus adiposum buccae (Bichat). *C* between the masseter and external surface of the buccinator muscles. The antrum of Highmore, *D* is filled with pus. The bony trabeculae surrounding the antrum are seen to be in considerable confusion, not adhering to the regular arrangement of the normal lamellar structure. The inferior turbinate, *E*, contains a well-walled off abscess cavity. The large fistula leading down into the mouth, *F*, is shown but in this section it appears to be connected merely with the abscess cavity in the cheek.

and of this number 7 per cent were directly due to abscessed teeth, 7 per cent to trauma, and the rest attributed to miscellaneous causes. There was a mortality of 5 per cent in this series all of the deaths occurring among children under 2 years of age.

PATHOGENESIS

The relationship of osteomyelitis to diseases of the antrum invading the anterior portion of the cavernous sinus through the ophthalmic veins is discussed by Eagleton. He believes that when the infective process originates in the teeth, it may occasion an acute osteomyelitis of the superior maxilla with involvement of the antrum; this rapidly perforates into the orbit and extends to the cavernous sinus. In these cases the infection travels not by continuity of tissue suppuration, but by retrograde thrombosis, which later is the cause of the nutritional death (gangrene with sequestration) of the osseous parts. Ballenger (3) likewise believes that acute osteomyelitis of the superior maxilla may be secondary to

buccal infection the involvement following an infection of the dental sac. The inference in such cases is that the infection originated in the tooth, from which a retrograde thrombophlebitis ascended causing not only nutritional death of tissue with consequent bony necrosis of antrum and ethmoids but also orbital abscess and finally involvement of the cavernous sinus.

An associated acute osteomyelitis is the result of the venous infection—not the cause of it. Drainage of the associated orbital abscesses cannot possibly control the disease since the infection has already invaded the cavernous sinus itself. The literature shows how invariably futile drainage operations have been performed on the orbit, the ethmoids, and maxillary antrum—futile because such drainage does not attack the thrombophlebitis itself. If these cases were diagnosed early it is possible that operation upon the thrombophlebitic veins would offer a fair prospect of recovery.

The clinical pictures of osteomyelitis of the maxilla in nurslings and infants have been variously described and many factors have been named as causes. The disease may set in during the first week or up to the ninth month of the infant's life; the greatest incidence is during the first 3 weeks after birth. Pathological manifestations of redness, swelling, purulent discharge, necrosis and sequestration may be present on any or all of the surfaces of the maxilla (orbital, nasal, facial, and palatal).

Many cases of osteomyelitis of the jaw in infants are now on record and the subject has been extensively reviewed a number of times within recent years. It is unnecessary to consider in detail all of the various opinions that have been held for the pathogenesis of this disease. In early medical literature (12) cases of this type were presented as curiosities and were published as records of the early age at which empyema of the antrum may occur rather than as contributions to the pathogenesis of the disease. In 1904 Kelly called attention to Schmiegelow's paper which had appeared 8 years before in which the clinical manifestations were attributed to an acute osteomyelitis of the maxilla. Kelly collected 17



Fig. 7 A vertical section in region of first permanent molar. The respiratory portion of the nose *A* with a break in the mucosa under the inferior turbinate indicating the rupture of an abscess. The palatal portion of the mouth indicates that a fistula has broken through the lower part of the maxillary sinus, *C* and the tract, *E* couring downward one part extending outward to a large abscess in the cheek, *D* and the other progresses downward into the oral cavity *B*. The facial wall of the sinus is completely destroyed and the presence of bone spicules is found. The zygomatic wall of the antrum as well as the root of the zygoma, *F* has been destroyed.



Fig. 8 Frontal section through first permanent molar. *A* The facial wall of the maxillary sinus is completely destroyed and a large fistulous tract containing spicules of bone, leading into the abscess in the fat pad of the cheek *B* and also finger-like projections reaching down into the tooth germ. (This photomicrograph is reversed but still concerns the same left side.)

cases including his own and concurred with the views of Schmiegelow. Since that time many theories have been advanced as to the cause of the osteomyelitis. The clinical pictures of all the cases on record are strikingly uniform although the points of entry and method of spread of the invading organism are still matters of controversy. A résumé of the various views that have been held is presented in the recent papers of Bass and Wilensky. Few of the cases reported have been studied histologically and it has been difficult to determine accurately the mechanism of the disease complex solely by clinical study. The patients are too often seen after the pathological condition is well established and as a consequence the primary seat of the process can only be inferred. Deduction by inference is the favorite method of clinicians in the reports which appear in the literature. We ourselves have never felt certain of the pathogenesis in the cases of ours that have recovered (11).

We have attempted to reconstruct pathogenic processes from clinical and histological evidence obtained by preparing serial sections of the head of an infant who succumbed to

an osteomyelitis of the maxilla (Fig 16). It appears that many possibilities are present following a nasal infection. Dogmatic statements have been made by proponents of each mode of invasion to account for the osteomyelitic process. Swoboda and Zarfl favor the theory of inflammation of the toothbuds in the course of sepsis of the newborn. This hypothesis does not fit in with the clinical history or the pathology in the majority of the cases reported in the literature. In his most recent publication on the subject Zarfl discusses the process as a necrotizing inflammation of the deciduous teeth. After an exhaustive histological study, he points out that the purulent inflammation does not begin in the tooth anlage itself but in the surrounding tissue and that involvement of the tooth anlage is secondary. On the basis of clinical and histological findings he divided his cases into two types (1) phlegmonous and (2) osteomyelitic, according to whether the soft parts or the bone were primarily involved. He presents differences in the clinical course that correlate with the underlying pathological picture. The final cause of the disease is the entrance of organisms into the soft parts or bone marrow of the jaw. The infection spreads from an inflammatory focus in the region of the jaw or from a distant focus. The cases Zarfl grouped under the phlegmonous type had circumscribed foci (erysipelas



Fig. 9. Section through the posterior choana, 1 showing the large abscess which has extended into the pterygoid fossa, B. There are two smaller abscesses in the region of the maxillary division of the fifth nerve C and a broken-down area immediately below the lateral wall of the nasal cavity.

of the face and stomatitis) the infective process extending to the jaw by way of the lymph channels. In the osteomyelitic type there was a spread through the blood stream from a distant focus such as would result from a furuncle.

According to Wilensky osteomyelitis of the maxilla differs in no way from osteomyelitis in general. The localization in the jaws in nurslings is due to such traumatic factors as those incident to childbirth, cleansing of the mouth, etc. The position of the thrombophlebitis governs the site of the necrotic process. It is Wilensky's belief that the local clinical manifestations in the maxilla are determined by the dominating position of the thrombophlebitis in the vascular channels supplying the jaws.

From careful evaluation of the case reports and data on the subject of osteomyelitis of the maxilla in infants it appears that the portal of entry and the method of spread of the primary infection may be variable. The fact that the entire tooth germ is sometimes exfoliated through the draining sinuses does not mean that the tooth anlagen were the original sites of the pathology or that they are especially liable to such involvement. It does not mean that the structures supporting them have been destroyed. In our case

despite the marked necrosis the tooth pulps withstood the destruction remarkably well.

The phase brought out in the study of this case is that nasal infection and sinusitis must be considered as a possible primary cause in osteomyelitis of the maxilla in infants. It has been suggested through the clinical reports in the literature that such etiological factors are frequently present but the fact that the sinuses are incompletely developed in infancy has obscured their significance. The maxillary sinuses and ethmoidal cells are always sufficiently advanced in their development at birth to be of clinical importance and the microscopical studies in the present case makes their importance fully evident. It would seem therefore that nasal infection and sinusitis should receive more serious consideration when the pathogenesis of osteomyelitis of the maxilla in infants is studied.

REPORT OF CASE

Osteomyelitis of the maxilla in an infant following a purulent rhinitis producing an ascending and descending abscess formation and a cavernous sinus thrombosis.

R. B. a white male infant, 3 weeks of age, was admitted to the Research and Educational Hospital. The mother stated that 9 days prior to admission, the infant had a thick, yellow nasal discharge. The infant was restless and refused to nurse. Fever was not present at this time. Two days later the nasal discharge became thin and mucoid in character and coincident with this the left eye became reddened and a swelling appeared on the upper eyelid. In the next 24 hours the lower eyelid became swollen. Forty-eight hours later the child was taken to a doctor who found a point of swelling on the left upper gum margin. The next day there was a spontaneous discharge of thick bloody purulent material from the left nostril. This was followed by a progressive decrease in swelling about the eyelids. The day before admittance the infant developed several small fluctuant areas on the left cheek near the outer canthus of the left eye and the lids again became edematous. Because of this the patient was brought to the hospital and admitted to the Pediatric Service. The mother believes that the infant has been without fever throughout the entire course of the illness. The patient was the second child of healthy parents. The mother had a normal, spontaneous delivery. The immediate neonatal history was normal and the patient did well until the time of the present illness.

Physical examination. The patient was a fairly well nourished infant. He did not appear acutely ill or toxic but was restless and irritable. No eruptions or lesions were present on the surface of the

body. Positive physical findings were confined to the head. The left side of the face was prominent. The left eyelid was reddened, oedematous and almost closed. The oedema of the eyelids extended beyond the outer canthus of the left eye almost to the temporal region. The left cheek and mandible were swollen and soft. The overlying skin had a faint purplish red color (Fig. 5). A scant amount of seropurulent material drained from the inner canthus of the left eye. The same type of discharge exuded from the left nostril and reappeared rapidly when wiped away. Pressure over the left maxilla increased the discharge from the left nostril. Upon rhinoscopic examination the material was seen to originate from below the inferior turbinate. The right nostril was clear. The left alveolar margin was swollen and boggy and a fistulous opening was present in the region of the first molar tooth. A thick yellow discharge drained from this area and was increased in quantity by pressure over the left maxilla. The pharynx was diffusely hyperemic throughout. The entire group of cervical lymph nodes on the left side was enlarged and firm to touch.

The urine was negative. Examination of the blood showed haemoglobin 68 per cent (Newcomer) red blood cells, 2,970,000 white blood cells, 13,650. The differential blood count revealed 49 per cent polymorphonuclears, 47 per cent lymphocytes, 3.5 per cent monocytes, and 0.5 per cent eosinophiles. Culture of the discharge from the left side of the nose eye and the alveolar fistula revealed *Staphylococcus aureus*.

The child's temperature on entrance was 99 degrees F but rose progressively in 4 days to 103 degrees F. Coincident with this rise there was an increase in the swelling and fluctuation of the areas described. A few fistulae developed on the left side of the face just lateral to the outer canthus of the left eye. The cervical swelling increased extending upwards to the zygoma. The patient failed to respond to supportive measures and died 6 days after entrance.

Postmortem examination. A terminal bronchopneumonia was revealed as the cause of death. A special histological study of the head was begun by Dr. Blayney of our Dental Department and collaborated in by Dr. Poncher and myself (13).

Microscopical report. The histological sections disclosed microscopical changes which were entirely in accordance with the clinical symptoms. The frontal section through the plane of the deciduous molar (Fig. 6) shows an old extensive osteomyelitic process of the inferior turbinal bone and also an involvement of the maxillary sinus which is much more recent. The lower border of the maxillary sinus presents a dehiscence from which a fistulous tract leads downward and then divides, one tract extending outward to a large abscess in the cheek and the other portion progressing downward into the oral cavity (Fig. 7).

A careful dental study of these histological preparations was made with particular reference to the



Fig. 10. Vertical section through the central region of the soft palate and the body of the lesser wing of the sphenoid. On the lateral wall of the epipharynx A is a cartilaginous projection which is the lamina medialis of the eustachian tube with the abscess encroaching upon it. The mandibular nerve is in close proximity to the abscess. The abscess, B, is located between the tensor and levator veli palatini muscles, from above and the buccinator belly of the superior pharyngeal constrictor below C. In the destruction of the zygomatic root the process extended into the pterygomaxillary fossa.

soft tissues covering the tips of the enamel cusps and incisal edges of the deciduous teeth. Each dental anlage showed a sufficient pad of soft tissue between the oral epithelium and the tooth crown precluding the possibility of any postnatal laceration or exposure of the tooth germ. It is quite evident that the involvement of the inferior turbinate is considerably older than that seen in the other regions of either the maxilla or mandible. These findings strongly suggest that the original infection was in the nasal cavity.

The frontal section through the plane of the first permanent molar region, reveals that the facial wall of the sinus is completely destroyed. A large fistulous tract containing apicules of exfoliated bone is seen to lead into the abscesses of the cheek and a finger like projection reaches downward, external to the tooth germ (Fig. 8). The zygomatic process of the antrum is seen to be destroyed with an extension of the phlegmonous process into the pterygomaxillary fossa. There are two smaller abscesses in the immediate vicinity of the maxillary division of the fifth nerve and also one small abscess beneath the periosteum of the lateral wall of the nasal cavity (Fig. 9). Sections were studied through the various planes from this point posteriorly such as the soft palate, the lesser wing of the sphenoid, the uvula, the body of the sphenoid and the sphenoidal fissure, and the greater wing of the sphenoid (Fig. 10). In the pterygoid fossa there is a small abscess and there are septic thrombi in a number of the adjacent veins. In a section anterior to the posterior wall of the pharynx, including the body of the



Fig. 1. Section at the level of the uvula, the body of the sphenoid, the sphenoidal fissure and the greater wing of the sphenoid. The posterior pharynx, A and pharyngeal space including the tonsil, B are normal but the abscess, C in the muscle planes, shows much destruction of surrounding parts and septic thrombi in the nearby veins. The abscess is located in close proximity to the eustachian tube.

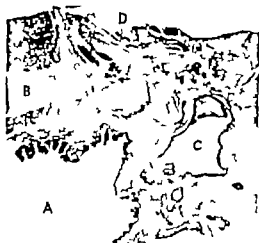


Fig. 2. Section in a plane just anterior to the distal wall of the pharynx, A and including a portion of the greater wing of the sphenoid, the basilar process, B and the abscess in the parapharyngeal area. The cavernous sinus area, D, including the internal carotid artery with the associated nerve trunks and ganglia (trigeminal [ophthalmic, superior and inferior maxillary (mandibular) branches], abducens, oculomotorius and trochlearis).

sphenoid and the basilar process, the cavernous sinus, the internal carotid artery with the associated nerve trunks and ganglia and a portion of the greater wing of the sphenoid are anatomically recognized (Fig. 13). There are several septic thrombi in the cavernous sinus (Figs. 13 and 14). The extension from the antrum through the maxilla was not limited to the distal direction but involved also the structure immediately above the deciduous central incisor and cuspid; the soft tissue between the oral cavity and the tooth crown was normal and unbroken (Fig. 15).

The study of the mandibular sections by Dr. Blayney disclosed an osteomyelitic process extending forward from the mandibular foramen to the region of the deciduous cuspid (Fig. 15, A). The degree of phlegmonous reaction and the amount of tissue destruction was much more pronounced in the maxilla than in the mandible. The mandible was separated from the maxilla at the time of autopsy so that it is impossible to trace the direct extension of the aforementioned infectious process. However, in a section through the mandibular foramen the abscess may be seen to enter the body of the mandible along with the mandibular nerve and vessels. Having seen that the syphagmatic process of the maxillary bone had been destroyed and that the contents of the maxillary sinus had entered the pterygomaxillary fossa, it is readily understood in what manner the extension could take place along the planes of the buccal fascia, the pterygoid muscles, the sheaths of the third division of the fifth nerve and the inferior dental artery, thereby entering finally the lower jaw through the mandibular foramen (Fig. 10).

In a section through the first permanent molar region, a large abscess is found immediately beneath the dental pulp, in close proximity to the mandibular nerve (Fig. 15, B). Inferior to this, the major portion of the original mandibular bone is involved in an osteomyelitic process. The body of the mandible is completely surrounded by a formation of new bone, the trabeculae of which are arranged at right angles to the surface. This arrangement of the trabeculae is not present on the normal side and by its form suggests an effort on the part of nature to withstand the effects of internal pressure. Studies of the deciduous molar teeth reveal a large area of destruction, extension of this process along the lateral wall of the tooth and complete disorganization of the enamel organ on the occlusal surface. The overlying soft tissue despite these pathological alterations, is intact, thereby discounting any dental focus as a pathogenic factor.

Throughout the entire mandibular series, we are unable to find a trace of the inferior dental artery from a point posterior to the cuspid region. This fact seems to substantiate the statement that the infection entered the lower jaw by extension along the vessel sheath, ultimately destroying it, and that the involvement of the lower jaw was not the result of a thrombophlebitis. In the anterior region of the mandible the structures are found to be normal in appearance and arrangement.

Summary of the clinical and histological findings. The clinical course of the patient becomes coherent after close scrutiny of the serial sections of the entire head. There is incontestable evidence that the site of origin of the infection was in the inferior turbinate. Following a purulent rhinitis and sinusitis,



Fig. 13. High magnification through the internal carotid artery which is filled with septic thrombi.

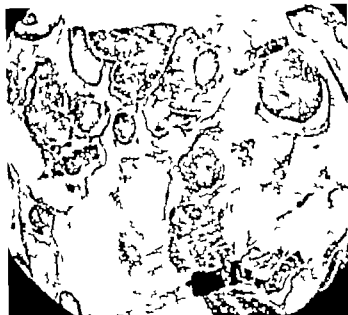


Fig. 14. Area of cavernous sinus showing veins thrombosed and containing septic thrombi.

the infant developed a periosteitis of the maxillary and ethmoid sinuses and periorbital cellulitis which later broke down (Fig. 5). From the suppurative process in the maxillary sinus and ethmoidal labyrinth septic thrombi invaded the venous channels producing a cavernous sinus thrombosis (Figs. 12, 13, 14). From the original site, the process extended to the maxillary sinus, producing a fulminating infection. The exudate in the maxillary sinus, by denuding the bone, caused a necrosis which gave rise to a fistulous tract at the floor of the sinus and broke through into the roof of the mouth (Figs. 6 and 7). The facial surface of the maxillary sinus was eroded by the carious process, thereby causing extension by continuity into the zygomatic arch and the soft tissues of the cheek (Figs. 7 and 8). The pterygoid fossa then became included in the extension from the zygoma (Figs. 9 and 10) and, by way of the fascial planes traveling along the pterygoid and buccinator muscles, the mandibular foramen became involved. The invasion of the foramen was by way of the nerve and vessel sheaths, and in the process one nerve was found to remain intact but the vessels were completely destroyed (Fig. 15). The parapharyngeal space contained a broken down abscess (Fig. 11).

The changes in the interior of the nose were most interesting. The osseous portion of the inferior turbinate was replaced by a necrotic mass. This is seen to be almost encysted, hence it would seem to be an older process (Fig. 6) than those which resulted from this infection. The epithelium of the turbinate is almost devoid of cilia although the mucosa is everywhere intact except in the inferior

meatus where it has been destroyed (Fig. 7). This destruction in the inferior turbinate represented the oldest change, the fistula at the floor of the maxillary sinus and the organized thrombus in the cavernous sinus were next in sequence.

TREATMENT

Neither experience nor literature seem to solve the problem of therapy in these cases. Extremes of conservatism and radicalism are represented, with a fortunate tendency to the former. A typical experience is that of Ballenger (2) who had 8 spontaneous recoveries out of 11 cases with no drainage other than that provided by the natural nasal orifices. Two of the cases drained by a spontaneous rupture through the orbit, one through the inner and another through the outer canthus of the eye. The 2 other cases required surgical interference, one an ethmoidal and the other an ethmoidal and orbital drainage. All of these cases recovered. Such an experience is not unusual.

Whether packs externally applied should be hot or cold is a matter of controversy; there being enthusiastic proponents for each form of therapy. Intranasal shrinkage and mild suction or irrigation are valuable. Procedures such as infraction of a turbinate, probing or irrigation of sinuses have not met with universal acceptance. The opinion often voiced is that these cases, representing as they do a fulminant type of pathological process, offer a



Fig. 5. A study of the mandibular series. A Shows the area immediately above the deciduous central incisor and cuspid involved. However the soft tissue between the oral cavity and tooth crowns is normal and unbroken. B Section through the first permanent molar region. There is an abscess immediately beneath the dental pulp and in close proximity to the mandibular nerve. The major portion of the bone surrounding this area is in old in the osteomyelitic process. The body of the mandible is completely surrounded by new bone with trabeculae arranged at right angles to the surface. C The section through the mandibular foramen shows the abscess entering the body of the lower jaw along with the vessels and the nerve, which really constitutes the manner in which infection was carried to the mandible. D The anterior region of the mandible shows a more active osteomyelitic process with sequestration and abscess formation.

better prognosis with a 'hands off' policy. Those who have voiced this ultra-conservative attitude have probably experienced in their own hands or those of their colleagues unfortunate sequelae of sepsis, osteomyelitis, meningitis and dural sinus thrombosis. They lean therefore toward the opinion that any manipulation in the nose may bring on dire consequences having no proof that the cases might not have gone on to such complications without these procedures.

In discussing the intranasal cases producing orbital symptoms and abscess, Faulkner advocates external evacuation of the abscess and exenteration of the ethmoids. Babbitt comments on the similarity in the symptoms of orbital cellulitis and cavernous sinus throm-

bosis; he believes that the percentage of recoveries under radical procedures and the serious prognosis without interference justifies initial nasal sinus surgery even in cases of doubt.

The treatment of orbital cellulitis and abscess varies with the severity of the symptoms according to Hawkins, who treats cases of pure edema intranasally. He quotes Logan Turner who was able to cure 14 of his 58 cases in this manner. Children with ethmoid suppuration and exophthalmos responded to shrinkage suction or irrigation in 24 to 48 hours, in Hawkins cases. He further advises that adults may respond to simple irrigation but according to him may require some type of operative procedure—intranasal, external,

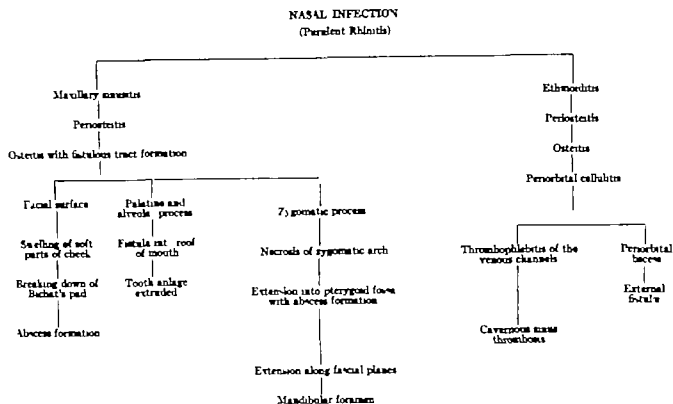


Fig. 16 Graphic representation of the method of spread from a primary focus in the nose to structures of the surrounding portions of the head. It is seen that this chronological representation follows very closely the comparative study of the historical sequence and the study of the histological series. Represented are possibly all the various routes by which a nasal infection may spread to the adjacent parts

combined or drainage of an orbital abscess. Whatever the type of operation it should be sufficiently radical to insure adequate drainage both of the infected sinus and the orbital pus. Such a radical attack should be carried out immediately when a cavernous sinus thrombosis manifests itself.

An expectant conservative attitude is adopted by Porter if there is a simple oedema of the lids (which he terms the first stage). This consists of shrinking the nasal mucosa, warm saline irrigations and cold compresses externally. If after 24 to 48 hours there is no improvement or if the condition has progressed he advocates for children who have cloudy ethmoids and antra a removal of the anterior ends of the middle turbinate opening into the ethmoid labyrinth and frequently uses intranasal antrotomy. In the adult the radical antrum operation is performed instead of the intranasal. If there is oedema of the lids and exophthalmos with limitation of motion (he terms this the second stage), an even more immediate and radical intervention is advised, consisting of an external ethmoid

exenteration and possibly removal of the floor of the frontal sinus and a sublabial approach to the antrum if it is involved.

On the basis of clinical reports it is difficult to arrive at an adequate evaluation of the therapy in these fulminant sinus infections. We can say definitely that conservative measures will suffice in the majority of cases, where the bacterial invasion is not virulent and its nidus is within natural cavities that may be readily drained. Such foci may be drained by shrinkage medication, suction or irrigation. With areas that are not so accessible a surgical approach becomes necessary. As Porter has shown, surgery is obviously indicated when the process is not responding to the expectant treatment and drainage is not established. Intranasal surgery has always been shunned in the presence of an acute infection and statistics seem to indicate that surgical intervention in fulminant sinus infections is attended by an appalling morbidity and mortality. Such statistics are logical only if we know at what stage of the infection drainage was attempted and the character of the procedure

(especially the incident trauma) External procedures rather than intranasal operations have been advised because of a possible spread to the meninges. We feel that here again we should choose the route nearest to the area which we desired to drain and—more important still—should as far as possible avoid operative trauma. We have frequently found it best to advise procedures in accordance with the ability of the surgeon.

CONCLUSIONS

An interesting histological survey directed toward study of the pathogenesis of osteomyelitis of the maxilla in an infant and of the means of extension and complication reveals a great number of diverse basic factors in cases clinically similar to each other. It is evident from a study of the literature that the portal of entry and method of extension may be variable. Dogmatic statements have been made by proponents of each mode of invasion but a careful study of our case has shown that the various modes of extension may all be involved in such processes. Evidence is presented to show conclusively that nasal infection and sinusitis may play an important rôle in the pathogenesis of such a process even in early life.

Very few of the cases recorded in the literature have had serial histological studies, and because it is difficult to determine the disease complex solely by clinical means, dogmatic and erroneous conclusions have been forced upon the rhinologist. The patients are often first seen after some time has elapsed so that the primary process is declared by inference only. The present study offers a logical explanation of many earlier unexplained cases.

We advise an expectant conservative attitude in the early stages of the disease when oedema of the lids is present. If the process does not show a tendency to regress and if symptoms become more marked surgical intervention must be contemplated.

The surgical approach can be intranasal or extranasal, the route determined depending upon the proximity to the focus to be drained and the chances of avoiding trauma. The

choice of procedure depends chiefly upon the technical skill of the surgeon.

In the case reported probably no therapy conservative or radical, could have halted the extensions of the bacterial invader or saved the life of the patient. Past experiences would indicate that palliative medication has its distinct merits in the treatment of the majority of cases. Radical interference undertaken at the proper time should give a good prognosis. Of the operative procedures surgery for drainage appears most advantageous.

BIBLIOGRAPHY

1. BARRETT, J. A. The diagnostic problem of orbital cellulitis. *Ann. Otol. Rhinol. & Laryngol.* 1930, 39, 444-457.
2. BALLINGER, H. C. Orbital cellulitis and abscess secondary to sinusitis. *Illinois M. J.* 1932, 61, 125-131.
3. BALLINGER, W. L. Diseases of the Nose, Throat and Ear. 6th ed. p. 543. New York: Lea & Febiger, 1930.
4. BARWICK, M. Disease of accessory nasal sinuses in scarlet fever. *Wien. med. Wchnschr.* Nov. 23 and Dec. 5, 1931.
5. BASS, M. H. *Am. J. Dis. Child.* 1928, 35, 65.
6. EAGLETON, W. P. Cavernous sinus thrombosis. New York: Macmillan, 1926.
7. FARRICANT, N. D. Cavernous sinus thrombosis following submaxillary resection. *Arch. Otol.* 1933, 17, 632-639.
8. FAULKNER, E. R. Rhinological aspects of cavernous sinus thrombosis. *Surg. Gynec. & Obst.* 1931, 52, 474-478.
9. HAWKINS, R. W. Relation of exophthalmos to nasal sinus disease. *New York State M. J.* 1933, 33, 65-68.
10. KELLY, B. *Edinburgh M. J.* 1904, 16, 302.
11. LUTHERER, F. L. Pathogenesis and end-results of dental sinus thrombosis. *Arch. Otolaryng.* 1934, 19, 410.
12. MAYER, E. *New York Med. Rec.* 1900, 60, 210.
13. POWERS, H. G. and BLAVET, J. R. *Am. J. Dis. Child.* 1934, 45, 730-735.
14. PORTER, C. T. Etiology and treatment of orbital infection. *Ann. Otol., Rhinol. & Laryngol.* 1932, 4, 1136-1141.
15. SARGENT, F. Concerning orbital inflammations in early childhood. *Monatsb. f. Augenb.* 1927, 75, 650-661.
16. SKOBIODA, V. *Verhandl. d. Versammlung d. Gesellsch. f. Kinderh. Breslau*, 1904, Therap. d. Gegenw. Berl., 1904, 14, 315.
17. THURMAN, C. F. Ethmoiditis in infants and young children with accompanying eye and orbital complications. *Tr. Am. Laryngol. Ass.* (50th annual meeting, Washington, D. C., May 1-5, 1933) 1933, 163, 182.
18. TUCKER, A. L. and REYNOLDS, F. E. *Intracranial Pyogenic Diseases*. Edinburgh: Oliver and Boyd, 1931.
19. WILDER, A. O. *Am. J. Dis. Child.* 1932, 43, 431.
20. ZARZ, M. *Zuschr. f. Kinderh.* 1930, 25, 266.

NORMAL HUMAN OVUM IN THE PRIMITIVE STREAK STAGE (APPROXIMATELY EIGHTEEN AND ONE-HALF DAYS)¹

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COMPARATIVELY few young human ova normal and anatomically complete have been described. The ovum² to be reported here seems to fulfill these requirements. In addition, an exact sex history has been obtained from the husband and wife as follows:

February 16, 1932, menstruation began.
February 22, 1932, menstruation ended.
February 26, 1932, coitus.
February 28, 1932, coitus.
March 4, 1932, coitus (evening).
March 10, 1932, entered hospital.
March 13, 1932, menstruation expected but failed to occur.
March 24, 1932, hysterectomy (morning).

The body of the uterus as removed measures 10.5 by 7.5 by 4.5 centimeters and has no pathological changes. The wall is 3 centimeters thick, 1 centimeter being endometrium. The cavity has no blood. On the posterior wall of the endometrium there is a slightly depressed hemorrhagic tissue 1 millimeter in diameter. Centered 1 millimeter directly beneath this is the blastocyst. The external measurements of the unfixed chorionic vesicle are 8 by 7 by 4 millimeters. The internal measurements (chorionic cavity) are 6 by 5 by 2.5 millimeters. The yolk sac is 1 millimeter in diameter before fixation. The amniotic cavity measured in the section is 0.66 by 0.816 by 0.20 millimeters in its greatest dimensions. The caliper measurements of the embryonic disc made on the model at 200 diameters are 115.9 millimeters long by 147.5 millimeters wide. The primitive groove similarly measured is 40.9 millimeters long. The length of the primitive streak including Hensen's node is 87.5 millimeters. Reduced to actual size the length of the disc is 0.58 millimeters, the width 0.74 millimeters, primitive groove 0.205 millimeters and the primitive streak including Hensen's node 0.438 millimeters.

These facts and those to follow support the conclusion that this ovum is normal and complete. The normal uterus was removed for the purpose of sterilization. The imbedded ovum was implanted at the usual site on the posterior wall of the uterus. The size and stage of development of the ovum were consistent with the menstrual and coital histories. Invasion of the maternal tissue by fetal elements was in active progress. The fundamental relationships of the embryonic plate, yolk sac, amnion, chorion, villi and endometrium were normal and agreed with those described by Bryce-Teacher, Frassa, Eternod and others which are accepted generally as normal. The cells of the embryonic plate were in active mitotic division. The Langhans' cells and the cytotrophoblast were multiplying rapidly by mitotic division. There was no cellular degeneration of the villi. Anchoring villi were few and were loosely attached.

The ovum and the embryonic anlage were anatomically complete and were sectioned and arranged serially. The entire unfixed blastocyst tissue together with a small amount of the surrounding endometrium was divided into four portions and placed in fixing solutions within 10 minutes after the maternal blood supply had been clamped. The block of tissue containing the embryonic anlage was fixed in formalin Zenker's solution, and the 3 others were placed respectively in Regaud's solution, 10 per cent neutral formalin, and formal Zenker's solution with subsequent osmic acid fixation. All the tissues were imbedded in paraffin. The block containing the embryonic structures was cut serially at 10 microns, and the sections were stained with hematoxylin and eosin. All other blocks were cut serially at 5 to 6 microns.

The stains used were acid fuchsin, methyl green, acid fuchsin Mallory III, phosphotungstic acid hematoxylin, osmic acid counterstained with methyl green, copper chrome hematoxylin, iron alum hematoxylin, scarlet

¹A comprehensive description of the embryo will be published later.

²From the Gynecological Service and the Henry Bahd Pavill Laboratory of St. Luke's Hospital and the Department of Anatomy of the University of Chicago. Aided by a grant from the Rockefeller Foundation to the University of Chicago.

red, Best's carmine Bielschowsky silver technique Mayer's muchematein Bismark brown and haematoxylin and eosin

ESTIMATION OF AGE

The coital history presents crucial evidence for determining the age of our ovum. Recent evidence indicates that ovulation usually occurs near the middle of the menstrual cycle (Allen et al). Accordingly the last ovulation in our patient occurred about March 3, 1932. The viability of injected spermatozoa in the human is variously stated to be from 1 to 3 days. Thus the coital relations that occurred on February 26 and 28 are too far separated from the calculated date of ovulation to be significant. The isolated and last coitus on March 4, 19½ days before operation coincides closely with the estimated date of ovulation. On this basis the maximum copulation age is 19½ days. The minimum copulation age is 14 days, since the patient was in the hospital 14 days prior to operation. Mall states that the copulation age is 24 hours longer than the actual or fertilization age. Deducting 1 day from the computed ovulation age the fertilization age of our ovum is 18½ days.

The calculated age is substantiated by comparison with other young human ova. The Grosser (Kl.) Ingalls Heuser Frass and Eternod (Vull) specimens (about 19 days) have larger measurements, the external diameter of the chorion being 10 millimeters. The Grosser and Ingalls ova have head processes, chordal canals, cloacal membranes and beginning medullary folds. The Frass and Eternod ova contain in addition neuronic canals, medullary grooves, and blood vessel formations in the body of the embryos.

The ova described by Miller Bryce Teacher I Peters Jung Verttens, and Strahl Beneke have internal chorionic measurements ranging from 0.44 millimeters to 3.8 by 2.2 by 1.2 millimeters. The measurements of the embryonic shields, while not absolutely trustworthy, vary up to 0.75 by 0.3 millimeters. The well known Miller and Bryce Teacher I ova have no definitive villi while one described by Peters has beginning villi formations. In the Jung specimen the villi evidence some branching.

In the Strahl Beneke ovum a primitive streak is present. The ages of these ova are stated by Streeter to be from 11 to 15 days and by Grosser from 12 to 18 days. (The Miller ovum is not listed in Grosser's classification. Grosser 1927.) Falkner recently described a human ovum associated with a good clinical history and estimated its age at 15 days. The villi are beginning to branch and the yolk sac is larger than the amnion.

Closely approximating the description of our ovum is that of the Mateer ovum, the age of which is placed by Streeter at 17 days. The measurements of the Mateer ovum, however, are slightly greater. The blood vessels of the villi contained primitive blood cells while in our specimen the vessels are empty.

Kindred in reporting the Goodwin ovum, calculates the age to be about 19 days. Although the given measurements are smaller than those for our ovum, the presence of the described head process indicates it to be more mature.

Our ovum with its primitive groove, allantois, blood vessel formations in the wall of the yolk sac, in the body stalk, in the chorionic membrane and in the villi with a yolk sac larger than the amnion and with branching villi falls into Group II of Streeter's classification. The internal measurements of the chorion are also within the limits given by Streeter for this Group. Since our ovum contains the earliest stage in the formation of a neuronic canal that has been described for the human, it is placed in the borderline between Groups II and III (Streeter). It is definitely less advanced than the ova of Group III (Grosser Kl.) Ingalls Heuser Frass, and Eternod Vull.

The more exact estimation of its age (18½ days), the immediate and excellent fixation, the favorable plane of section, and the completeness of the specimen make possible a precise classification of this ovum in the series of human ova.

THE VILLI

The villi vary in size and shape and cover the entire surface of the blastocyst (Fig. 1). The longest is 0.1 millimeters. Many are branched once and a few twice. Each has a central mesodermal core and a covering of

syncytium and Langhans' cells. The Langhans' cells are small, cuboidal, or oval with scant granular cytoplasm large clear nuclei and one or two nucleoli (Fig 2). Each cell has a definite membrane. Many are in mitotic division. Glycogen can be stained in these cells. The vacuolization of the cells as demonstrated by Falkner was not present. The syncytium is a finely granular protoplasmic film with nuclei distributed through it. It is spread irregularly over the surface of the Langhans' cells and stained deeply. The nuclei have a single nucleolus. Glycogen could not be demonstrated in this syncytium. Mitochondria stain as thin threads. In many places there is a brush border. The syncytium does not in this specimen completely surround and wall off the implantation cavity the picture differing in this respect from that described by other writers.

VASCULAR ANLAGE

There are blood vessels in various stages of development in the villi chorion body stalk and in portions of the wall of the yolk sac. In the villi chorion and body stalk the development is similar while in the yolk sac the formations differ and are considerably more advanced.

All the larger villi contain angioblastic strands or short tubes, while many of the smaller villi do not. In the absence of specific study and plotting there is no manifest difference in the number or degree of development of vessel formations in the villi chorion and body stalk. All stages from fine mesodermal strands to fully formed short endothelial tubes are present. The strands usually located near the center of the villi consist of groups of mesodermal cells with indistinguishable cell membranes. They are short and in serial sections have no connections with other neighboring strands or vessels. Some contain vacuoles in the central portion. Because the cell boundaries could not be discerned, it can not be stated whether the vacuoles are intracellular or extracellular. By confluence and enlargement of the vacuoles a lumen is formed surrounded by a ring of cytoplasm and flattened nuclei. These formations likewise are isolated. A few of the formations are branched.

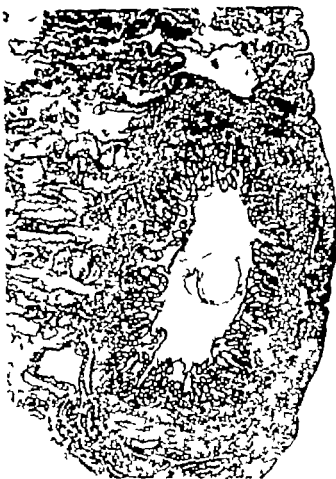


Fig 1 Photomicrograph of a slightly oblique section of blastocyst embedded in endometrium. Section 15-2 X12

Since the vessel primordia are distributed evenly through the villi chorion, and body stalk, since the individual strands and vessels are independent of connections or communications with neighboring strands, and since the formations are equally well differentiated over the entire chorion they probably arise *in situ*. There are no cells in the lumen of the endothelial tubes in the villi, such as Streeter described for the Mateer ovum and called future blood cells. In the body stalk there is similar differentiation of mesoblastic cells into strands—some solid some with vacuoles, and some with a lumen. There is no evidence that these as yet join with the strands of the chorionic membrane. In a place at the edge of the body stalk is a single blood island formation similar to those observed in the wall of the yolk sac.

In the wall of the yolk sac, the blood vessel formations are restricted to the caudoventral



Fig. 5. Photomicrograph of a fetal wandering cell in contact with a decidual cell at the left. Stained with Best's carmalum to show glycogen. $\times 975$.

Glycogen is present in large cells scattered through the decidua at the sides and base of the blastocyst (Fig. 5). Beneke, P. Meyer, Bryce-Teacher, Peters, Strahl and Falkner describe these large cells, but make no statement concerning their glycogen content which in our material distinguishes them from maternal cells. Beneke, Meyer, Strahl and Falkner believe these cells to be of fetal origin while Bryce-Teacher suggests that they are maternal cells. Peters states he is uncertain of their origin.

Two types of fetal wandering cells are evident. In our specimen their origin can be traced definitely to the cytotrophoblast. Cells in the cell columns at the tips of the villi identical with Langhans cells increase in size, the cytoplasm concentrates about the nuclei and the acid stain is taken with avidity. The cells increase in size, the cytoplasm becomes more dense and the nuclei have one or more clefts and a single large nucleolus. The cytoplasm becomes still more dense and granular, remains concentrated about the nuclei and stains more intensely with acid dyes. In the cytoplasm mitochondria now appear stained as long thin threads and filaments. Figure 6 illustrates such a cell among its neighbors and separated from the decidua by a venous space. The mitochondria are similar in sections fixed in Regaud's solution and in formal Zenker's with subsequent osmic acid fixation for two days. In Figure 7 a wandering cell of one type is shown in the decidua adjacent to a

vessel. By comparison to a decidual cell the fetal cell is larger. It contains glycogen in this preparation and the decidual cells do not. It has mitochondria whereas the decidual cells do not. The nuclei of the decidual cells are even rounded or oval with 1, 2 or 3 small nucleoli in contrast with the cleft nuclei and single large nucleoli of the fetal wandering cells. The other type of fetal wandering cell is illustrated by Figure 5. These cells stain darkly and invade the decidua in streamer-like formations, one cell behind the other. Their shape varies during invasion. Many are elongated and tenuous as in Figure 5. Others located in maternal capillaries are spherical. Many contain glycogen and in some mitochondria stain as threads and short rods. Some have several nuclei.

SYNCYTIUM

The theory that syncytium originates from the cytotrophoblast is upheld by Peters, Streeter, Jung, Miller and others. The theory that it originates from maternal endothelial cells has been so convincingly disproved that it can safely be disregarded. In the ovum reported here the formation of the syncytium is followed from the cytotrophoblast in more detail than has previously been done.

The syncytium develops similarly to the fetal wandering cells as noted above up to the appearance of mitochondria. From here on, a variation occurs. After the formation of the large cytotrophoblastic cells with dense cytoplasm and mitochondria, two or more of the cells fuse to form a multinucleated mass or such a single cell is surrounded and taken up by an already formed syncytial mass. The staining reaction of the syncytium is similar to that of the large cytotrophoblastic cells. Mitochondria remain as thin threads in the syncytium (Fig. 8). Identical changes with the subsequent formation of syncytium take place in the Langhans cells within the confines of the villi. Since syncytium develops from the Langhans and the cytotrophoblastic cells in a similar manner it is evident that these latter two cell types are fundamentally similar and have a common origin. Many of the syncytial masses have brush borders (Fig. 9). Brush borders or prickles

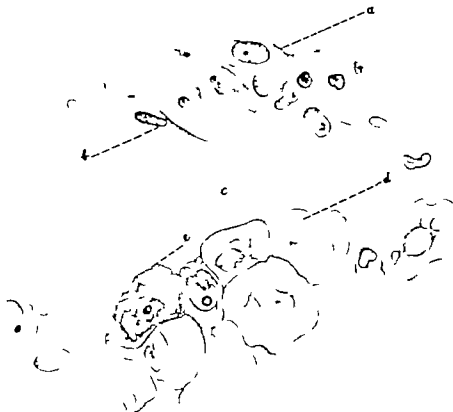


Fig. 6 Camera lucida drawing of venous space in penetration zone. *a* Endometrial stromal cells, *b* endothelial lining of venous space *c* lumen of venous sinus *d* cytotrophoblast replacing endothelial wall *e* cytotrophoblastic cell with mitochondria $\times 725$

processes have been noted by Jung Greenhill Beneke Marchand and others Peters believes these irregular borders are not prickly processes but rather a frayed deposit on the surface. The masses penetrating deepest into the maternal tissue in our ovum do not have these borders and Bryce Teacher report similar findings. Numerous masses contain lipid droplets stained with both scarlet red and osmic acid (Fig. 9). In the penetration zone many syncytial masses with brush borders contain large and small vacuoles. In sections fixed and stained for lipoids these vacuolated regions do not stain. It is probable that the brush borders are associated with phagocytic activity of the cell masses as suggested by Bartelmez.

In the penetration zone *Zwischenzone* or zone of necrosis Grosser reports an abrupt transition from the trophoblast to the maternal tissue in the Kleinhaus ovum and believes the maternal tissue is not destroyed but merely pushed outward. Veit Strahl Beneke and P Meyer also note this outward displacement. Streeter states there is no destruction

or ingestion of maternal stroma cells in the Miller ovum. On the other hand Bryce and

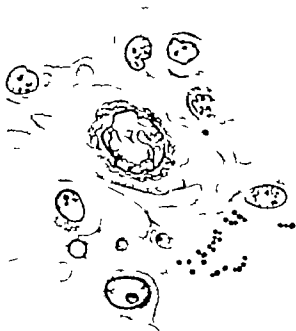


Fig. 7 Drawing of a section containing a fetal wandering cell with mitochondria amidst maternal cells. (Stained with aniline acid fuchsin and methyl green) Camera lucida $\times 1065$



Fig. 5. Photomicrograph of a fetal wandering cell in contact with a decidual cell at the left. Stained with Best's carmalum to show glycogen. $\times 95$.

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noid In some places formation of fibrinoid from degenerating syncytium is noted Small amounts are evident, scattered through the advancing cytotrophoblast from which it apparently originates In other places, the origin is undoubtedly in degenerating maternal cells at the boundary zone In contrast to the description by Bryce and Teacher and Jung, in which the fibrinoid is arranged in a layer completely around the ova, it is found only in occasional places in our ovum, while in the Peters' ovum it is entirely wanting When it occurs it is located at the junction of the decidua and the cytotrophoblast which it separates sharply The layer is usually thin In Greenhill's specimen, fibrinoid was being engulfed by the syncytium

Fibrin occurs mainly in the formation of thrombi In many places a capillary opens into the intervillous space, one endothelial wall is lost and the other continues along the edge of the normal decidua Adherent for a considerable distance along this remaining capillary wall is a laminated thrombus made of fibrin, and white and red blood cells Fibrin is located only in the vessels in the penetration zone

SUMMARY

- 1 A normal and anatomically complete human ovum, age 18½ days is described (Fig 1)
- 2 The tissues were fixed in various solutions within 10 minutes after the clamping of the maternal blood supply
- 3 An accurate and valuable clinical history is given.
- 4 The embryonic disc is slightly oval and contains
 - a. The earliest stage in formation of a neurenteric canal so far described for the human,
 - b. A primitive streak and groove (Figure 1)
 - c. A Hensen's node,
 - d. A cloacal membrane,
 - e. An allantois.
- 5 The villi surround the entire blastocyst (Fig 1) Some are branched (Fig 1) There are a few anchoring villi (Fig 2)
- 6 Blood vessel formations arise *in situ* They are identified in the villi, chorionic mem-

brane, body stalk, and yolk sac wall (Fig 3) There are primitive blood cells in the vessel formations of the yolk sac (Fig 3)

7 The cytotrophoblast is of fetal origin (Fig 2) and contains glycogen In it there is no reticular framework in sections stained by Bielschowsky's silver method (Fig 4)

8 Two types of fetal wandering cells develop from the cytotrophoblast. Both contain glycogen and mitochondria The latter are stained as thin rods and filaments (Figs 5 and 7)

9 The syncytium originates from the cytotrophoblast and Langhans' cells in a similar manner (Figs. 2 and 8) The mitochondria stain as thin threads (Fig 8) Many syncytial masses have brush borders (Fig 9)

10 In the penetration zone there is degeneration of maternal tissue (Fig 4) as well as an outward pressure exerted by the growing blastocyst (Fig 1)

11 The slight leucocytic infiltration in the implantation site is limited principally to the decidua capsularis

12 Fibrinoid is formed from both fetal and maternal tissues in the penetration zone

We wish to express our appreciation for the valuable suggestions and aid given by Dr George W. Bartelmez.

BIBLIOGRAPHY

- 1 ALLEN PRATT BLAND and NEWELL J Am M Ass 1928, 91 1018.
- 2 BRYCE TEACHER An early ovum imbedded in the decidua (Contributions to the study of the early development and imbedding of the human ovum, University of Glasgow Press) 1908.
- 3 Idem Tr Roy Soc Edinburgh, 1924, 53 pt iii, 533-567.
- 4 Idem. McIntyre ovum. Tr Roy Soc Edinb 1924, 53 pt. iii, 546
- 5 DEBEYRE, A. J Anat. et d. Physiol, 1912 48 448-515
- 6 ETERNOLO A. C. F Arch. Ital de biol., 1894, 21 xiv
- 7 FALKNER, N. J Obst. & Gynec. 1932, 39 471
- 8 FETTER. Anat. Ans 1910 37 Erg. Heft, 116.
- 9 FRANKL, L. Arch f mikr Anat u. Entwickl., 1908 70 492-505
- 10 GLACOMINI. Arch. Ital. de biol 1898, 29 1-22
- 11 GREENHILL, J. P Surg., Gynec. & Obst 1927 45 493.
- 12 GROEBER, O. Anat. Hefte, 1931 47 649.
- 13 Idem. Fruchentwicklung, Eihautbildung und Placentation des Menschen und der Säugetiere Deutsch Frauenheilkunde Geburtshilfe, Gynaek u. Nachbargebiete, 1927 vol 5
- 14 HEINKE and HOFBAUER. Ztschr f Geburtsh. u. Gynaek 1911 68 665-688.
- 15 HENZOO, M. Am. J Anat 1909 9 361-400

16. HERTER, C H Contributions to Embryology 1933, No 138, p 25-267
17. HIRUKELON S vom Arch f Anat u Entwicklungs-gesch 1898, p 1
18. HOWALLS Contributions to Embryology Carnegie Inst 1918, 7 No 23 11
19. JONES-STONE, R W J Obst & Gynec Brit Emp 1914, 25 23
20. JUNO, P Beitrage zur fruehesten Eadlabettung beim menschlichen Weibe Berlin, 1908
21. KETTEL Arch f Anat u Physiol Anat abth 898, p 250
22. KIMDRICK, J E Goodwin ovum Am J Anat 1933, 53 22
23. LINZANMEIER, G Arch f Gynaek 1914, 102 1-17
24. MIFRETT N, J Ztschr f Geburtsh u Gynaek 1894, 30 -97
5. MYER, P Arch f Gynaek 1924, 122 38
26. MILLER Berl klin Wchnschr 1913, 50 865
27. MILLER, A G Surg Gynec & Obst, 1933, 56 1020
28. VIRNOT C S T Am Gynec Soc Phila 904, 29 395
29. MORROW Am J Obst & Gynec 1927 13 234
30. Idem J Am M. Ass 1930, 94 478
31. MOELLERDOFF W v Ztschr f Anat u Entwickl-Inggesch 1921 62 352-405
32. PETERS, H Ueber die Einbettung des menschlichen Eies Leipzig und Vienna Franz Deutsch, 1890
33. REICHERT C. B Phys u med Abhandl d kgl Akad der Wiss zu Berlin, 1873
34. ROMEL DORIA, T Arch f Gynaek 1904, 76 433
35. SCHLAGENHAUFER and VEROCAY Arch f Gynaek 19 6, 105 151
36. SEEF GRAY v Arch f Anat u Entwicklungs-gesch 1896, p 1
37. STRAU, H Anat Hefte, 19 6, 54 115
38. STRAU and BERKE Ein junger menschlicher Embryo Wiesbaden Bergmann, 19 0
39. STRELETZ, G L Blastere ovum Coast to Embryo No 43, Publication N 272, p 180, 1920
40. Idem Miller embryo Contribution to Embryology No 92 Publication No 363 p 51-48 1926.
4. TEACHER, J H J Obst & Gynec Brit Emp 924, 31 166-177

STUDIES ON ABSORPTION AND EXCRETION IN SEGMENTS OF THE COLON OF MAN¹

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MUCH conflicting experimental evidence exists concerning the absorption of substances other than water by the large intestine. While we were working with a large group of colostomized patients on the combined intestinal service of the Mayo Clinic it occurred to us that they presented conditions ideally suited to the elimination of the usual fallacies inherent in investigations of colonic absorption, and that, without inconvenience or danger to patients observations could be made which would be of benefit to all patients. The particular advantages offered by colostomized patients were as follows: (1) The omnivorous colon of man could be studied, rather than the colons of strictly carnivorous or strictly herbivorous animals. (2) The divided colon would prevent error due to regurgitation of the clyma into the absorbing ileum. (3) Short distal segments could be thoroughly evacuated thereby eliminating any errors due to failure to recover unabsorbed fractions. (4) Thorough cleansing of the easily accessible, short, distal segment would prevent bacterial fermentation in experiments with carbohydrates.

Test substances were chosen with a view to obtaining additional evidence of absorption other than disappearance from the colonic lumen as well as for utility of these substances otherwise. For these purposes a number of observations were made, using methylene blue, atropine, glucose, sucrose and arsenic. Experiments were also performed to determine whether some of these substances, orally or intravenously introduced would be excreted by the colonic segments.

METHOD

The distal colonic segment was thoroughly cleansed by irrigations with warm tap water rubber catheters were used, as is illustrated in Figure 1. That this cleansing process was

effectual is evidenced by the fact that the content of a segment, removed after cleansing, failed to cause any loss of fermentation, when incubated for 4 hours at 37 degrees C with 5 grams of glucose.

Following the process of cleansing, the substance to be tested was instilled in solution through the rubber catheter, and left in the segment for the duration of the observation as determined by its nature. At the end of this time, the unabsorbed fraction was removed by irrigation, and its quantity determined. That the unabsorbed fraction could effectually be removed in this manner was demonstrated by instilling 30 milligrams of arsenic as neo-arsphenamine, in solution, and immediately removing it by irrigation with 1,000 cubic centimeters of water. Analysis of this returned fluid by the Osterberg modification of the Gutzeit method resulted in recovery of 97 per cent of the instilled arsenic.

ABSORPTION

Results with methylene blue are given in Table I, those with atropine, in Table II, and those with glucose in Table III.

To determine metabolic factors during the disappearance of glucose from the colonic segments, observations were made on 3 individuals, free of diabetes, on whom colostomy had been performed at the level of the sigmoid, on one individual, who had diabetes graded 3, on whom colostomy had been performed at the level of the sigmoid, and on one individual who had undergone obstructive resection at the level of the sigmoid and who had questionable latent diabetes. Under basal conditions estimations of the respiratory quotient and heat production, in calories per square meter per hour, were made by the gasometer method (2), and the values for blood sugar were determined by the Folin Wu method. Following introduction of 30 or 50 grams of glucose into

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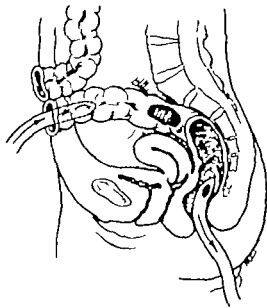


Fig 1. Anatomical condition after double barrel or loop colostomy and method of using catheters.

the distal colonic segment, the same determinations were made at hourly intervals for 3 hours, with an additional determination of blood sugar at the first half hour. Table IV shows that in each case mentioned in the foregoing there was an increase in heat production, and in 3 instances there was an increase in respiratory quotient above the basal levels at some point during the disappearance of 9.42 to 48.75 grams of glucose from the distal colonic segments.

Among individuals whose carbohydrate metabolism was not impaired, the values for blood sugar maintained a level or fell slightly but among individuals who had diabetes, definite increases in values for blood sugar accompanied the absorption of the glucose (Table IV).

The metabolic changes in Case 20 graphically represented are shown in Figure 2.

Sucrose administered parenterally to man is not utilized, but it has been shown by Keith Wakefield and Power that 97 per cent to 98 per cent of it is excreted in the urine within 24 hours. If sucrose is instilled into distal segments of the colon its subsequent excretion in the urine will be evidence of its absorption by the colon. The invertase hydrolysis method of determination of su-

TABLE I—ABSORPTION OF METHYLENE BLUE

Case	Operation performed	Methylene blue retained	Time, hours	Urine
1	Type X colostomy at sigmoid	500 per rectum	24	Green
	Type X colostomy at sigmoid	500 per rectum	4	Green
2	Loop colostomy at sigmoid	500 into lower loop	1	Green

TABLE II—ABSORPTION OF 1/75 GRAIN (0.00086 GM.) ATROPINE INSTILLED INTO LOWER LOOP

Case	Operation performed	Time, hours	Physiological response		
			Salivation	Pupils	Pulse rate, beats per minute
4	Loop colostomy at sigmoid	34	No effect	No effect	
		34	Dry mouth	No effect	
		3	Dry mouth	Pupils dilated	
5	Loop colostomy at sigmoid	35	No effect	No effect	
		34	Dry mouth	No effect	
		34	Dry mouth	No effect	
6	Loop colostomy at sigmoid	3	Dry mouth	Pupils dilated	
7	Mikulicz operation on descending colon	34	No effect	No effect	54
			No effect	No effect	23
		34	Dry mouth	No effect	90
			Dry mouth	Pupils dilated	23
8	Obstructive resection at sigmoid	35	No effect	No effect	32
			No effect	No effect	90
		34	No effect	No effect	23
			Dry mouth	Pupils dilated	20

crose as described by Jolliffe Shannon and Smith was employed.

Two observations on individuals who had undergone colostomy at the level of the sigmoid showed that following instillation of 5 grams of sucrose into the distal colonic segment, urinary excretion of sucrose immediately began. 36 milligrams were recovered in 1 hour and 29 milligrams in 2 1/4 hours, in the urine of the 2 subjects. Following removal of the sucrose from the colonic segment, urinary excretion of sucrose abruptly ceased. These

TABLE III.—ABSORPTION OF GLUCOSE

Case	Operation performed	Glucose instilled	Time, hours	Glucose recovered	Absorbed, per cent
9	Obstructive resection at sigmoid	20 gm. into distal loop	5	0	100
1	Type X colostomy at sigmoid	20 gm. per rectum	3	11.87	40.7
11	Type X colostomy at sigmoid	20 gm. per rectum	3	7.8	61.0
12	Type X colostomy at sigmoid	15 gm. per rectum	3	4.4	70.4
13	Sigmoid loop colostomy	20 gm. into distal loop	3	1.17	94.3
14	Sigmoid loop colostomy	15 gm. into distal loop	3	0.27	98.19
15	Colostomy at middle of descending colon	20 gm. per rectum	3	3.8	71
16	Loop colostomy at transverse colon	20 gm. into distal loop	3	0.19	99.95
7	Cecostomy	20 gm. into cecal stoma	3		100.0
8	Cecostomy	20 gm. into cecal stoma	3		100.0

observations were not recorded in Tables V or VI

Observations made on an individual who had undergone colostomy at the level of the sigmoid disclosed that 5 grams of sucrose instilled into the distal colonic segment resulted in urinary excretion of sucrose, and that this excretion continued for 48 hours, 382 milligrams were excreted in the first 24 hours, and 273 milligrams in the second 24 hours. This indicates the slowness of absorption of sucrose. The individual mentioned in the foregoing was 1 of 5 who had undergone colostomy at levels ranging from the sigmoid to that of the middle of the transverse colon. Excretion of sucrose in the urine ranged from 2.6 per cent to 12.5 per cent in 24 hours, and from 13.1 per cent to 19.3 per cent in 48 hours; the percentages are based on amounts instilled into the distal segments of colon. It was observed that the higher the colostomy and thus the larger the absorbing surface of colon the smaller was the fraction of the total amount of sucrose instilled which was excreted in the urine. This suggested that much of the sucrose not recovered in the urine might have been hydrolyzed to dextrose and levulose, and absorbed as such since only small

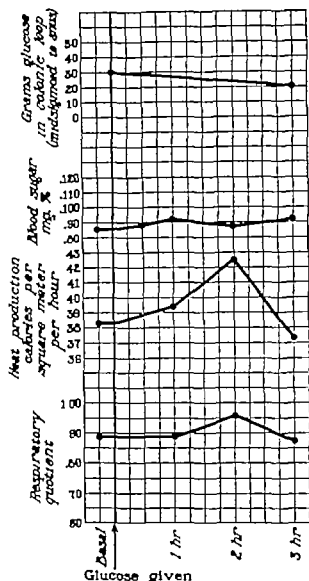


Fig. 3. Metabolic changes in Case 20

fractions, ranging from 0.023 grams to 0.135 grams remained in the colonic segments at the end of the observation (Table V)

Arsenic instilled as neoarsphenamine, in quantities of 0.15 grams, into the distal colonic segments of 7 persons who had undergone colostomy at the level of the sigmoid resulted in the disappearance of 25 per cent to 100 per cent of the instilled arsenic within 4 hours; the arsenic of the residual fraction was determined by the Osterberg modification of the Gutzeit method. Of arsenic instilled into 2 persons who had undergone cecostomy, 69 per cent and 100 per cent respectively, disappeared in 4 hours. Excretion of arsenic in the urine did not occur in these experiments. However when the amount of neoarsphenamine instilled

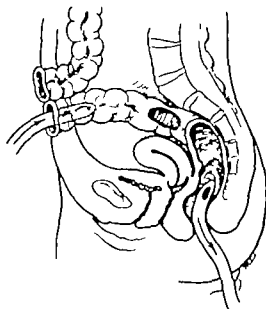


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		16	Dry mouth	No effect	
		35	Dry mouth	No effect	
6	Loop colostomy at sigmoid	3	Dry mouth	Pupils dilated	
7	Milex operation on descending colon	5	No effect	No effect	14
			No effect	No effect	20
		55	Dry mouth	No effect	90
			Dry mouth	Pupils dilated	20
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TABLE V—SUCROSE ABSORPTION

Case	Operation performed	Sucrose in- stilled per rectum, gms.	Hours after instillation	Sucrose re- covered in urine, gms.	Sucrose ex- creted per cent	Sucrose re- covered in segment, gms.
4	Sigmoid loop colostomy	5	4	0.080		
			8	0.113		
			24	0.180	7.6	
			48	0.273	13.1	
13	Sigmoid stage barrel colostomy	5	1	0.65	13.0	0.133
16	Sigmoid loop colostomy	5	24	0.6073	13.3	0.023
			48	0.370	10.13	0.023
17	Descending loop colostomy		24	0.492	4.9	0.24
25	Obstructive resection transverse	5	4	0.133	8.6	0.31

TABLE VI—ABSORPTION OF ARSENIC IN FOUR HOURS FOLLOWING INSTILLATION OF 0.15 GRAM OF NEOARSPHENAMINE PER RECTUM

Case	Operation performed	Arsenic recovered from colonic segment, mgm.	Arsenic apparently absorbed, per cent
20	Loop colostomy at sigmoid	22.5	25.0
20	Loop colostomy at sigmoid	12.7	20.4
21	Loop colostomy at sigmoid	8.7	71.0
2	Loop colostomy at sigmoid	7.0	76.7
3	Loop colostomy at sigmoid	1.0	93.7
24	Loop colostomy at sigmoid	0	100.0
25	Loop colostomy at sigmoid	0	100.0
16	Circumcision	0.3	60.0
27	Circumcision	0	100.0

*There was no arsenic in the urine either before or after instillation of arphenamine.

of the colon in the following 5 hours although urinary excretion of the dye occurred at that time.

Glucose intravenously administered in amounts of 25 grams was not excreted by the distal part of the colon.

Sucrose intravenously administered in amounts of 5 grams was not excreted by the colon in the subsequent 18 or 19 hours, although urinary excretion of 87 per cent to 89 per cent of the administered amount occurred during that time.

Results with arsenic are given in Table VIII.

COMMENT

The undoubted functions of the colon consist of storage and propulsion of the stool secretion of mucus to facilitate its passage, and absorption of water (17-24). There is additional experimental evidence to indicate that from cæcum to anus definite amounts of protein carbohydrate, salts, metals, anaesthetics, and drugs may be absorbed (4, 5, 7, 22, 27, 32, 33). Bacteria may be absorbed rapidly from the colon, and experiments on animals indicate that rectally introduced glucose results in a greater deposit of carbohydrate in the liver than occurs after its intravenous administration (8, 24, 28).

Functionally the proximal and distal halves of the colon are regarded as dual organs. The proximal half is regarded as the absorptive portion and the distal half as the organ of

TABLE VII—ABSORPTION OF ARSENIC FOLLOWING INSTILLATION OF 0.6 GRAM OF NEOARSPHENAMINE PER RECTUM

Case	Date	Operation performed	Arsenic in urine after instillation, mgm.	Arsenic in discharge from proximal segment, mgm.	Arsenic recovered from distal segment, mgm.
18	9-1-33	Obstructive resection of sigmoid			
	9-2-33		0.44		
	9-3-33			0.87	2.4
20	8-30-33	Sigmoid loop colostomy			
	9-1-33				
	9-2-33		1.5		
	9-3-33			1.0	6.0

*There was no arsenic in the urine before instillation of arphenamine.

storage and propulsion. This division of function is based on the following observations: (1) The proximal part of the colon is developed from the midgut along with the absorptive small intestine, while the distal part is derived from the hindgut. (2) The proximal part of the colon is of larger caliber, and its walls are thinner than the smaller, thick-walled distal portion. (3) The prevailing types of movement in the proximal part of the colon, particularly at the cæcum, are churning and antiperistalsis, whereas in the distal part the prevailing type of movement is propulsive. (4) The content of the proximal part of the colon

TABLE VIII.—EXCRETION OF ARSENIC AFTER ADMINISTRATION BY MOUTH OF TWO TABLETS OF TREPARSOL

Case	Date	Operation performed	Arsenic in urine, mgm.	Arsenic secreted by distal segment of colon, mgm.
30	9-17-13	Type X, anastomosis at sigmoid		
	10-17-13			
	11-7-13		6	Trace
	12-14-13			
	1-24-14		1	
	12-15-13			
	1-15-14			
	2-15-14			
	10-1-14			
	12-16-13			
40	10-7-13	Subtotal colectomy with ileostomy		
	11-17-13			1
	12-18-13			
	1-25-14		8	14
	2-7-14			
	2-19-14		15	1
	3-10-14			
	10-20-13		1	
	11-23-13			

is liquid whereas that of the distal part is solid or semisolid.

Opinion is still divided as to whether material, other than water which disappears from the lumen of the colon, is actually absorbed. It has been pointed out that the major fallacies in the assumption that colonic absorption is the cause of this disappearance, are (1) the probability of antiperistalsis carrying the test substance up into the absorbing ileum (2) the inability completely to cleanse the undivided colon, and the consequent questionably complete removal of the unabsorbed fraction of test substance and (3) the possibility of destruction of the test substance by bacterial action.

In our work these objections were overcome by (1) the operative division of the colon, which precluded the possibility of loss by antiperistalsis (2) the shortness of the colonic segment, from which a test substance could be completely removed immediately after its introduction (3) the possibility of complete

cleansing of the easily accessible colonic segment so that the remaining intestinal content is incapable of fermenting glucose by incubation *in vitro* (4) the use of further criteria of absorption, other than disappearance of the test substance from the colonic lumen.

The further criteria just mentioned require comment. The evidences of absorption of methylene blue, of atropine, and of arsenic, which were employed have been recorded in applicable tables.

Much dissenting opinion exists over the question of colonic absorption of glucose (3, 4, 6, 9, 10, 11, 12, 16, 17, 18, 20, 21, 23, 25, 26, 27, 28, 29, 30, 31). Failure of values for blood sugar in the peripheral blood to increase during the disappearance of glucose from the lumen of the colon has been the basis of some conclusions as to the failure of the colon to absorb glucose. Actually if the factors by means of which sugar is removed from the blood stream are not impaired, the values for peripheral blood sugar would be expected to be unaltered or to be perhaps slightly reduced due to pancreatic stimulation during the colonic absorption of glucose. This is what occurred during our observations of subjects who were free of diabetes. On the other hand in the observations on a diabetic subject, the values for peripheral blood sugar definitely increased during the absorption of glucose from the colonic segment. In addition, increases above the basal level in the respiratory quotient or in heat production in calories per square meter per hour or in both, occurred at some time during the colonic absorption of glucose, in all observations.

If a sugar which is not metabolized in the body is absorbed unchanged by a colonic segment, its subsequent excretion into the urine, and its recovery therefrom is definite proof of absorption. For that purpose sucrose was instilled into distal colonic loops and recovered unchanged, in the urine in significant amounts in all observations. Absorption of this substance was shown to be extremely slow since urinary excretion, although beginning within an hour from the time of introduction of the sucrose into the colonic loop continued for 48 hours, but could be terminated by removing the sucrose from the colon. Only a portion of

the instilled sucrose was absorbed as such by the colonic segment. It is possible that the remainder may have been hydrolyzed to dextrose and levulose and absorbed as such.

Numerous metals and metallic salts have been shown to be excreted in the feces. Our work on excretion was designed to determine whether the same substances shown to be absorbed by the distal part of the colon, were excreted by the same segment when introduced orally or intravenously. The results with methylene blue, glucose, sucrose and arsenic have been presented.

CONCLUSIONS

Distal segments of the generally regarded least absorptive or distal half of the colon of man were shown to absorb methylene blue, which subsequently was excreted in the urine, atropine, which caused pupillary dilatation and decreased salivation, sucrose, which subsequently was excreted in the urine, arsenic as neoarsphenamine, which subsequently was excreted in the urine and in the stools from the proximal part of the intestine, and glucose, which disappeared from the colonic segment, accompanied by an increased respiratory quotient or increased heat production, or both. In the presence of impaired utilization of carbohydrate, increases in values for peripheral blood sugar accompanied this process.

Distal segments of the colon of man did not excrete methylene blue, which had been orally administered in amounts sufficient to appear in the urine, glucose, when 25 grams of it had been intravenously administered, sucrose when 5 grams of it had been intravenously administered. Arsenic, when administered orally as treparsol was excreted by distal colonic segments in amounts which in some instances exceeded the urinary excretion over the same period of time.

BIBLIOGRAPHY

1. BINY, REEVE, and SCHMOLL, EMILE. The treatment of gastric and duodenal ulcer. *Calif State J. M.*, 1914, 12, 361-366.
2. BOOTHBY, W. M., and SAKHOFORD, IRENE. Laboratory Manual of the Technique of Basal Metabolic Rate Determinations. Philadelphia W. B. Saunders, 1920.
3. CAMPBELL, H. F. Rectal alimentation in the nausea and inanition of pregnancy. *Intestinal Inanition,*

- an important factor and the true solution of its efficiency. *Tr. Am. Gynec. Soc.*, 1878, 3, 368-398.
4. CARPENTER, T. M. Human metabolism with enemas of alcohol, dextrose and levulose. *Carnegie Inst.*, 1925.
5. CERNY, V. V. and LATSCHEMBERGER, J. Physiologische Untersuchungen ueber die Verdauung und Resorption im Dickdarm des Menschen. *Virchow's Arch.*, 1874, 59, 161-190.
6. ECKLING, W. W. Absorption of dextrose from the colon. *Arch. Surg.*, 1933, 26, 134-152.
7. EDWALL, D. L., and MILLER, C. W. A study of two cases nourished exclusively per rectum with a determination of absorption, nitrogen-metabolism and intestinal putrefaction. *Tr. Coll. Phys. Phila.*, 1903, 24, 225-246.
8. FISCHER, VIRGINIA. Absorption of yeast from the large intestine. *Proc. Soc. Exper. Biol. & Med.* 1932, 29, 400-404.
9. FRANK, WALTER, and WAOMER, R. J. Studies of the fermentable blood sugar after parenteral and rectal administration of glucose. *J. Met. Research*, 1924, 6, 375-391.
10. HALASZ, ALADAR VON. Die Resorption und das biologische Verhalten der verschiedenen Zuckerarten im Dickdarm. *Deutsch. Arch. f. klin. Med.* 1910, 98, 433-474.
11. HART, PAUL, and HALASZ, ALADAR V. Ueber die Resorption des rectal eingegebenen Traubenzuckers. *Biochem. Ztschr.*, 1918, 88, 337-344.
12. HUBBARD, R. S. and WILSON, D. C. An experiment on the absorption of glucose given by rectum. *Proc. Soc. Exper. Biol. & Med.*, 1922, 19, 392-394.
13. JOLLIFFE, NORMAN SHAWGOW, J. A., and SMITH, H. W. The excretion of urine in the dog. III. The use of non-metabolized sugars in the measurement of the glomerular filtrate. *Am. J. Physiol.* 1923, 100, 301-312.
14. KEITH, N. M., WAKEFIELD, E. G., and POWER, M. H. The excretion and utilization of sucrose when injected intravenously in man. *Am. J. Physiol.* 1932, 101, 63-64.
15. LARSON, L. M., and BARGEN, J. A. Physiology of the colon. *Arch. Surg.*, 1933, 27, 1-50.
16. LEVI, DAVID. A note on the glucose enema and its value in postoperative treatment. *Brit. J. Surg.* 1927, 15, 282-285.
17. MCNEALY, R. W. and WILLEMS, J. D. The absorption of glucose from the colon. Preliminary study of the glucose enema. *Surg. Gynec. & Obst.* 1929, 49, 794-798.
18. Idem. Absorption of dextrose from colon: a study of the effects of chemical excitants and of stimulants on dextrose enema. *Arch. Surg.*, 1931, 22, 649-657.
19. OSTERBERG, A. E. A modification of the electrolytic Gutzeit apparatus for estimation of arsenic in biological material. *J. Biol. Chem.* 1928, 76, 19-22.
20. PERUSSA, G. L., JR. The solution of choline in proctocolitis. *Surg., Gynec. & Obst.* 1932, 54, 770-784.
21. PREREMAN, J. J. The absorption of glucose per rectum. *Am. J. Med. Sc.* 1930, 179, 520-528.
22. RAMSDEY, F. W., BARGEN, J. A., and BUTE, L. A. The Colon, Rectum, and Anus. Philadelphia W. B. Saunders, 1933.
23. REICH, FELIX. Ueber Resorption von Kohlehydraten von der Schleimhaut des Rectums. *Arch. f. exper. Path. u. Pharmacol.* 1902, 47, 231-249.
24. ROSENFIELD, GEORGE. Ueber die Behandlung der Zuckerkrankheit. *Klin. Wchnschr.* 1909, 1, 937.

- 25 RUMMO and VARELA Reaktive Hypoglykæmie durch parenterale Zuckernahrung *Klin. Wchnschr* 1932 1 2370-2374
- 26 SCOTT E L and ZWISLOWART J F B Blood sugar in man following the rectal injection of dextrose *Arch. Int. Med.* 1932 49 221-226
- 27 SEMOUR A R and BYWATER, H W Amino-acids and sugars in rectal feeding *Brit Med J* 1913, 1 361-366
- 28 SMUTER, M., and ARNOLD, LLOYD Absorption of bacteria from large intestine *Proc. Soc. Exper. Biol. & Med.* 1932, 29 494-496
- 29 DE TAKATS, G Push fluids the surgeon's postoperative order *Am. J. Surg.* 1931 11 30-44
- 30 TALLERMAN, K H Rectal absorption of glucose. *Quart. J. Med.* 1930, 13 356-362.
- 31 VARELA and RUMMO. Rektale Dextrosezufuhr und Blutzucker *Med. Klin.* 1932, 18 851-853
- 32 VOLT C. Absorption of albuminous matters in the large intestine. *Neues Repertorium f. Pharmacol.* 17 4, Practitioner 1869, 2 370
- 33 VOLT CARL, and BAUER, JOSEPH Ueber die Aufnahme im Dick- und Dünndarm *Ztschr. f. Biol.* 1870 5 536-570 *Jahrb. d. ges. Med.* 1872 134-138

SOME PRINCIPLES OF LOCAL ANÆSTHESIA

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PAIN is a psychic experience well known to all of us (Foerster). Undoubtedly, pain is often a warning that our body or some organ of it is diseased and needs rest. Pain is, however not always a bene factor, it may also be a useless torturer. As to operative pain and pain of incurable disease, the ancient Hippocratic adage "*divinum est opus sedare dolorem*" has remained valid to this day.

Physical correlative of the psychic experience of pain sensation consists in an excitation process of the afferent nervous system (Foerster).

The nerves supplying the individual organs are for the most part well known, unless they are thoroughly understood good anaesthesia is impossible. No doubt there may be a great difference between the sensitiveness of one individual and another or of one organ and another but if a really good anaesthesia is to be obtained this difference should not be relied upon but each individual and each organ should be considered sensitive not only skin muscle fascia, bone joints pleura peritoneum, but also stomach bowel, bladder, parenchymatous organs vessels and so on. Sensory nerve fibers can be demonstrated in the stomach bowel vessels, lungs and so on—although not in cartilage—but very probably the receptors of the bowel are different from those of the skin. Pressure crushing stinging, burning of the skin are painful whereas the same stimuli cause no pain if applied to the bowel or to the lung. It is likely however that contractions stretching anaemia of the bowel sufficient duration and summation of various stimuli changes in the vicinity are capable of producing pain.

It must be stressed that even the smallest sensitive field during operation should receive due care. Sensitivity of the smallest spot may spoil the entire effect of anaesthesia, for the patient is not conscious of the painless phases of the operation and remembers only the pain conveyed from the sensitive part.

I have been studying the question of local anaesthesia for more than 25 years. At the surgical clinic of Professor Dollinger we performed 6 000 operations under local anaesthesia—95 per cent of all cases—as reported by Professor Dollinger in 1913 at the International Congress of Surgeons in London. This number has not been reached by any other surgeon as yet. Together with my 1 200 cases operated upon at the Zita Hospital 7 200 operations have been performed under procaine anaesthesia, tutocaine has been used in 6,675 cases, nupercaine in 4,940, pantocaine in 4,982, this makes a total of 23 797 major operations and if I add our 8 000 operations performed on out patients I can report 31,797 operations performed under local anaesthesia, without a single fatality during operation. This is such a great number and the result is so excellent that it seems worth while to draw a few useful conclusions. Methods have been amply commented upon in the works of Schleich, Braun, Redus and Pauchet, therefore I only wish to call attention to some practical points.

CHOICE OF ANÆSTHETIC

The first important problem is the choice of a good anaesthetic. Since I had no fatality with procaine, the question may be raised, why I abandoned it and why I later abandoned tutocaine and nupercaine as well. I can easily answer that "better" is the enemy of "good." In any case it seems worth while to examine this problem more closely.

What is required of a good anaesthetic? This question I answered in my lecture at the Congress in Sopron in 1929 as follows:

1. It must be a substance capable of paralyzing the nerve tissue at a low concentration, without being a protoplasm poison to the other tissues.

2. The anaesthetic possesses a specific affinity to the nerve tissue and if it enters the circulation it may seriously intoxicate the central nervous system therefore it must be

retained at the site of injection as long as possible.

3 The change brought about in the sensory nerve by the anæsthetic must cease after a certain time without leaving a trace

4 The anæsthetic must be transformed locally by the tissues in order to be released into the circulation in a detoxified state.

5 From a surgical point of view it is important that it be water soluble, boilable, and not liable to decomposition during sterilization. It must not irritate the tissues or cause pain on injection. It must mix with epinephrin in order to be retained locally.

Even though an anæsthetic fulfills all these requirements we must still take into account the fact that the more efficacious an anæsthetic is, the greater its toxicity. In the living organism, however, toxicity of many compounds becomes modified under the influence of certain factors. It must be specially emphasized that the diffusion speed of an aqueous solution depends on the quality of the dissolved substance on the permeability of the membranes separating the solutions, and on the concentration of the solution.

The main cause of my changing anæsthetics, therefore, was my endeavor to use substances of the lowest possible effective concentration in order to depress the diffusion speed. In a major operation 150 to 180 cubic centimeters of anæsthetic solution is required. If a 1 per cent procaine solution is employed this means not only the introduction of 1.5 to 1.8 grams of foreign substance into the organism but also the use of a 1 per cent solution the absorption of which on account of its relatively high concentration is quicker than that of a 0.25 per cent tuteocaine or a 0.1 per cent pantocaine solution. This will certainly increase the toxicity. That this is true is evidenced by the fact that palpitation, pallor, diffuse sweating, rapid pulse, even nausea and vomiting during or shortly after anæsthesia were almost constant concomitant symptoms of procaine anæsthesia, whereas since I have used the solutions of low concentration the symptoms mentioned have become an extremely rare occurrence.

Second the anatomical site of the operation needs careful consideration. On the head

neck or near the spinal column one cannot, with impunity, use as great quantities of anæsthetic as may be used far from the central nervous system e.g. on the extremities, whence the anæsthetic must pass many more cells before reaching the central nervous system and in this way be more likely to become thoroughly modified or detoxified.

Not only have intoxications ceased to appear in our patients but better anæsthetic effects are obtained even in the hands of the young members of the staff of my clinic. This improvement I am convinced, is due not only to ample opportunity afforded staff members to see and to learn the technique of anæsthesia and the suggestive influence on new patients of those already operated on, but also to the fact that a sufficient quantity of this diluted anæsthetic to anæsthetize any operative field may be safely used. Nevertheless I would warn against injecting too great an amount at once: the dose should remain far below the toxic dose. If the patient should feel pain during operation the few milligrams of anæsthetic which will have been already detoxified allow for the injection of a considerable amount of additional anæsthetic solution. This continuous supplementing dosage according to the needs, makes it possible to complete under local anæsthesia any operation started under local anæsthesia. The fact that in complicated operations of long duration we do not inject large quantities of anæsthetic at once may account for our record of not a single fatality in a vast number of cases.

METHODS

With adoption of certain modifications, I returned to and use extensively the Schleich, Hackenbruch and Oberst methods—the latter of course, without tourniquet—all methods of nerve block anæsthesia—trigeminal, cervical, Kulenkampff plexus, the Keppler-Haertel methods and so on—carried out as well endoneurally as perineurally. In the abdominal cavity I use the Braun anæsthesia of the solar plexus of the hypogastric plexus, also parasceral anæsthesia and infiltration of mesenteric attachments. Paravertebral anæsthesia I now use exclusively in kidney operations.

Complicated methods in general are likely to fail. Their drawback is that in case of failure another method has to be resorted to, and this must be one performable in the operative field. By complicated method I do not mean a block anæsthesia in which the nerves are outside the operative field but may be reached without changing the patient's posture to any great extent. In general, anæsthesia should be brought nearer to the field of operation.

I abandoned not only paravertebral anæsthesia, but also trunk anæsthesia of the major and minor splanchnic nerves (suggested formerly by myself), and the solar plexus anæsthesia of Kappis. I do not employ the high sacral anæsthesia as recommended by Schuster, nor the method of pouring anæsthetic solution into the abdominal cavity as suggested by Seidel. I shall not return to spinal anæsthesia and I am not inclined to use even the controllable form as described by Kirschner (control by air sufflation) as long as I hear that there is one fatality in each 300 to 500 cases and that excruciating headaches lasting for days and bladder paralyses are often observed.

OBJECTIONS AND CONTRA INDICATIONS TO LOCAL ANÆSTHESIA

What are the drawbacks of local anæsthesia?

It is said that it requires a special training. This is true, but it is not a disadvantage. Moreover in most operations the methods have been so greatly simplified that they may be easily learned.

Occasionally fall of blood pressure or certain toxic symptoms will occur. These however, become progressively more uncommon, moreover, they cannot be compared with troubles observed in general anæsthesia.

It has been asserted too that some greater vessel may be injured. With some care this can easily be avoided and even if an injury occurs it will cause no serious trouble, provided the injury is perceived and no anæsthetic is injected into the vessel. In infiltrating the deep layers I never use too sharp needles and in this way the orientation as to the layers is made easier. Tissue necrosis

caused by anæsthetics has also been described, I myself never saw a single case of this and I believe that those who have observed it must have infiltrated tense tissues or used great amounts of some highly concentrated fluid.

Suppuration cannot be placed to the account of local anæsthesia, for both syringe and solution may and should be adequately sterilized.

What are contra indications for infiltration anæsthesia?

Most treatises on this topic mention malignant tumors, sepsis, inflammatory diseases, youth, and obesity or hysteria in women. In our day a malignant tumor is not considered a contra indication by the majority of surgeons for, if performed far enough from the neoplasm, inoculation need not be feared. Moreover operations for cancer of the tongue, cheeks, tonsils and throat have lost their bad reputation since the introduction of local anæsthesia.

In my opinion general anæsthesia is contra indicated in septic patients, as for the rest, I never saw suppuration at the site of the injection.

No doubt active hyperæmia increases excitability of sensory nerves whereas passive hyperæmia depresses the same. Nevertheless, I do not recommend the classic Oberst anæsthesia, and even less do I recommend applying the constricting bandage to an anæsthetic field since constriction itself is painful. Many surgeons are disinclined to employ local anæsthesia in inflammatory conditions because they fear that forcing the solution into the tense tissue may cause pain, they are afraid also that infective matter may be conveyed into healthy tissues, and give rise to a spreading infection. I never have been restrained by inflamed tissues from operating under local anæsthesia and I never saw any unfortunate consequence. Of course if the field is of small size, I prefer circular infiltration in the healthy tissues or I perform block anæsthesia if feasible, but if it seems necessary I do not refrain from infiltrating the inflamed tissue. In such cases I use a very fine needle and I inject the solution at a slow rate. I do not enter healthy regions from inflamed ones. In my experience infiltration of inflamed tissues never caused spreading of the infection, it has rather tended

toward quicker amelioration or even subsidence of the inflammation, possibly by abolishing pain. Of course I readily admit that there are cases in which a superficial ethyl chloride inhalation is to be preferred to a more complicated local anaesthesia (e.g. mastitis and so on)

Hohmeier and a few other surgeons describe a method of infiltration which consists in pushing the needle forward until bone contact is felt and infiltrating the layers while pulling back the needle. This method is not too gentle. The solution should always precede the needle, because in this way infiltration is entirely painless and injury to vessels is not likely to occur.

Anaesthesia must be induced without causing pain. Methods using intravenous or other kinds of narcosis for performing local anaesthesia are needless. Local anaesthesia needs gentleness, patience, and anatomical knowledge. If it fails the patient should be given ethyl chloride or ether but he must not be allowed to suffer. I have simplified the technique of inducing anaesthesia to such an extent that the patient feels only one or at most two superficial needle pricks. In this manner I am able to operate on a steadily increasing number of children under local anaesthesia.

I often read that fat or hysterical women are not suited for local anaesthesia. I cannot agree with this. In fat women I consider narcosis contra-indicated whereas the majority of hysterical women are very well suited for local anaesthesia, especially if they are kept in the hospital for a few days before being operated upon.

I have not observed any untoward effect from block anaesthesia either in diabetic or in arteriosclerotic patients. Epinephrin however injected near to necrotic tissues, may cause spread of necrosis.

ADVANTAGES AND ABSOLUTE INDICATIONS

And now what are the advantages of local anaesthesia? A point of economy is that no medical assistant is needed during operation or until the awakening of the patient. The operation is not complicated by a simultaneous procedure the narcosis, which is fraught with a graver danger than the operation itself

since although it is almost out of the control of the operating surgeon he is nevertheless responsible for its risks.

Local anaesthesia can be employed in all cases in which general anaesthesia would be dangerous. It has a great importance in bone fractures. If 20 cubic centimeters of a 0.1 per cent pantocaine solution is injected between the bone ends, pain and muscular contraction promptly cease and the fracture may be easily and painlessly reduced. No block or circular infiltration anaesthesia is needed. In general medical practice it saves a great deal of suffering. The general practitioner cannot be required to perform under narcosis lumbar or cisternal puncture or puncture of the pleural or peritoneal cavity of joints of a paranephritic abscess (nor is the practice indicated) but he should be required to anaesthetize the skin at the puncture site and the entire way of the needle. In this way breakage of needles will be avoided and the patient will not be in fear of a future repetition of the procedure. The argument that the patient has to suffer a prick even if anaesthetized and that a puncture is performed so quickly as to make anaesthesia superfluous does not hold. The single layers, especially the pleura and the peritoneum are very sensitive, and even after the needle has been introduced, the slightest movement of the needle during tapping may cause considerable pain.

Local anaesthesia is indicated in all operations if there is no particular contra-indication—psychic causes, greater simplicity of general anaesthesia—because it is simpler and safer.

There are certain operations which I never perform under general anaesthesia. In heart disease, emphysema, bronchitis, arteriosclerosis, kidney disease, in impaired liver function or in bad operative risks narcosis is contra-indicated. Cosmetic operations, and interventions that are not absolutely necessary (removal of scars, benign tumors) certain plastic operations, herniorrhaphies—especially umbilical hernias of fat women—I perform exclusively under local anaesthesia, because I consider it inexcusable to expose the patient to the danger of narcosis if the same operation can be performed safely under local anaesthesia. The same applies to trepanation,

OUR CASES SINCE 1926

Type of anaesthesia	Site of operation	Number of cases	
		Local anaesthesia	Local anaesthesia + narcosis
Block anaesthesia	Head	337	13
	Neck	300	none
	Thorax	304	8
	Abdomen	150	22
	Upper extremity	181	4
	Lower extremity	337	3
	Hernia	3,060	6
	Rectum	818	none
Brazo solar plexus	Stomach	560	20
	Bile passages	1,033	01
	Spleen	4	none
Mesenterial	Small intestine	01	10
	Colon	131	none
	Appendix	4,018	248
	Female genitalia	20	7
	Male genitalia	8	2
Paravertebral (Ruhmer Nusskov type) (Frigstad type)	Kidney	2	2
	Female genitalia	0	
	Vagina	17	none
Parascroal	Rectum	46	1
	Bladder	23	6
	Prostate	27	5
Total Linear infiltration		11,036 1,778	490 (3.5 per cent)
Total Narcosis		(80.9 per cent) 14,320 (16.6 per cent) 3,023	

Total number of operations 8,233

operations on the face, mouth neck, thorax and the genito-urinary apparatus, which operations I perform almost exclusively under local anaesthesia. I employ narcosis only in certain abdominal operations and in operations on the extremities if local anaesthesia has proved unsatisfactory or if narcosis is simpler and not contra indicated in long standing jaundice, however, narcosis may be followed by serious injury to the liver

I readily admit that postoperative pneumonia is observed also in patients operated upon under local anaesthesia, it shows, however, a more favorable course and is more easily treated. There is no doubt that local anaesthesia is less likely to be followed by postoperative heart, liver, and kidney damage.

It is not fair to compare mortality of operations performed under general and local anaesthesia, respectively, because many poor risks are operated upon under local anaesthesia who were refused operation, or they were operated upon under narcosis and died. In seriously impaired liver function the results of local anaesthesia are conspicuously better than those of general anaesthesia.

What is still to be required of an ideal anaesthetic?

In my opinion it would be of great benefit if the anaesthetic or at least the hypaesthetic effect could be prolonged. The effect is sufficient for the performance of the most extensive operations, it would be desirable, however, if the operative field could be made painless for at least 24 hours.

After narcosis, the patient, being still under the narcotic effect, does not cough, whereas in local anaesthesia, after pain sensation of the wound has returned, the patient does not breathe deeply and does not ventilate his lungs. If, however, the pain could be abolished for 6 to 18 hours, the patient would dare to move to breathe deeply. In this way many bed sores, many cases of pneumonia could be prevented and the patient could be spared much pain, for pain decreases with each additional hour elapsing after operation. After 24 hours the wound does not ache at all. In my opinion therefore, after anaesthesia, a painless period lasting 24 hours should be aimed at. In this respect nupercaine opened a new perspective and if we succeed in securing a 24 hour painlessness the ideal goal of entirely painless operative healing will be reached.

toward quicker amelioration or even subsidence of the inflammation, possibly by abolishing pain. Of course I readily admit that there are cases in which a superficial ethyl chloride inhalation is to be preferred to a more complicated local anesthesia (e.g. mastitis and so on).

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Anesthesia must be induced without causing pain. Methods using intravenous or other kinds of narcosis for performing local anesthesia are needless. Local anesthesia needs gentleness, patience and anatomical knowledge. If it fails the patient should be given ethyl chloride or ether, but he must not be allowed to suffer. I have simplified the technique of inducing anesthesia to such an extent that the patient feels only one or at most two superficial needle pricks. In this manner I am able to operate on a steadily increasing number of children under local anesthesia.

I often read that fat or hysterical women are not suited for local anesthesia. I cannot agree with this. In fat women I consider narcosis contra-indicated, whereas the majority of hysterical women are very well suited for local anesthesia, especially if they are kept in the hospital for a few days before being operated upon.

I have not observed any untoward effect from block anesthesia either in diabetic or in arteriosclerotic patients. Epinephrin, however injected near to necrotic tissues, may cause spread of necrosis.

ADVANTAGES AND ABSOLUTE INDICATIONS

And now what are the advantages of local anesthesia? A point of economy is that no medical assistant is needed during operation or until the awakening of the patient. The operation is not complicated by a simultaneous procedure, the narcosis, which is fraught with a graver danger than the operation itself

since, although it is almost out of the control of the operating surgeon, he is nevertheless responsible for its risks.

Local anesthesia can be employed in all cases in which general anesthesia would be dangerous. It has a great importance in bone fractures. If 20 cubic centimeters of a 0.1 per cent. pantocaine solution is injected between the bone ends, pain and muscular contraction promptly cease and the fracture may be easily and painlessly reduced. No block or circular infiltration anesthesia is needed. In general medical practice it saves a great deal of suffering. The general practitioner cannot be required to perform under narcosis lumbar or costal puncture or puncture of the pleural or peritoneal cavity of joints of a paraneuritic abscess (nor is the practice indicated), but he should be required to anesthetize the skin at the puncture site and the entire way of the needle. In this way breakage of needles will be avoided and the patient will not be in fear of a future repetition of the procedure. The argument that the patient has to suffer a prick even if anesthetized and that a puncture is performed so quickly as to make anesthesia superfluous does not hold. The single layers, especially the pleura and the peritoneum, are very sensitive and even after the needle has been introduced the slightest movement of the needle during tapping may cause considerable pain.

Local anesthesia is indicated in all operations if there is no particular contra-indication—psychic causes, greater simplicity of general anesthesia—because it is simpler and safer.

There are certain operations which I never perform under general anesthesia. In heart disease, emphysema, bronchitis, arteriosclerosis, kidney disease, in impaired liver function or in bad operative risks, narcosis is contra-indicated. Cosmetic operations, and interventions that are not absolutely necessary (removal of scars, benign tumors), certain plastic operations, herniorrhaphies—especially umbilical hernias of fat women—I perform exclusively under local anesthesia, because I consider it inexcusable to expose the patient to the danger of narcosis if the same operation can be performed safely under local anesthesia. The same applies to trepanation.

OUR CASES SINCE 1926

Type of anæsthesia	Site of operation	Number of cases	
		Local anæsthesia	Local anæsthesia + narcotics
Block anæsthesia	Head	387	13
	Neck	509	none
	Thorax	804	8
	Abdomen	190	8
	Upper extremity	181	4
	Lower extremity	337	3
	Hernia	3,660	6
	Rectum	818	none
Brown scolar plasma	Stomach	860	20
	Bile passages	1,053	91
	Spleen	4	none
Mesenteral	Small intestine	91	10
	Colon	11	none
	Appendix	4,018	248
	Female genitalia	20	7
Paravertebral (Rikner-Noskov type) (Fragrant type)	Ribs (thoracoplasty)	8	1
	Kidney	8	2
	Female genitalia	9	1
	Vagina	17	none
Parasacral	Rectum	46	1
	Bladder	23	6
	Prostate	27	5
Total Local infiltration		11,056 1,773	439 (2.5 per cent)
Total Narcosis		(80.9 per cent) 14,730 (18.6 per cent) 3,025	

Total number of operations 8,231

operations on the face, mouth, neck, thorax and the genito-urinary apparatus which operations I perform almost exclusively under local anæsthesia. I employ narcosis only in certain abdominal operations and in operations on the extremities if local anæsthesia has proved unsatisfactory or if narcosis is simpler and not contra-indicated, in long standing jaundice however, narcosis may be followed by serious injury to the liver

I readily admit that postoperative pneumonia is observed also in patients operated upon under local anæsthesia, it shows, however a more favorable course and is more easily treated. There is no doubt that local anæsthesia is less likely to be followed by postoperative heart, liver, and kidney damage.

It is not fair to compare mortality of operations performed under general and local anæsthesia respectively, because many poor risks are operated upon under local anæsthesia who were refused operation, or they were operated upon under narcosis and died. In seriously impaired liver function the results of local anæsthesia are conspicuously better than those of general anæsthesia.

What is still to be required of an ideal anæsthetic?

In my opinion it would be of great benefit if the anæsthetic or at least the hypæsthetic effect could be prolonged. The effect is sufficient for the performance of the most extensive operations, it would be desirable, however, if the operative field could be made painless for at least 24 hours.

After narcosis, the patient being still under the narcotic effect, does not cough, whereas in local anæsthesia, after pain sensation of the wound has returned, the patient does not breathe deeply and does not ventilate his lungs. If, however, the pain could be abolished for 6 to 18 hours, the patient would dare to move, to breathe deeply. In this way many bed sores, many cases of pneumonia could be prevented and the patient could be spared much pain, for pain decreases with each additional hour elapsing after operation. After 24 hours the wound does not ache at all. In my opinion therefore after anæsthesia, a painless period lasting 24 hours should be aimed at. In this respect nupercaine opened a new perspective and if we succeed in securing a 24 hour painlessness the ideal goal of entirely painless operative healing will be reached.

VARIATIONS OF THE FEMALE PELVIS IN RELATION TO LABOR

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VARIATIONS of the female pelvis which are not abnormalities in the usual sense occur with relative frequency a fact to which I called attention in 1932 (4). A common variation which we have studied is characterized by a shortening of the transverse diameter of the superior strait often associated with an increased anteroposterior diameter. In such pelvis this plane appears essentially round while in some, the anteroposterior diameter is actually increased over that of the transverse making the pelvis of the true dolichopelvic type described in 1886 by Turner.

In 1933 Caldwell and Moloy reported on the anatomical variations of female pelvis and classified them into 4 general groups—the gynecoid, android, anthropoid and platypelloid types. These authors further subdivided their classification to include pelvis which may be admixtures of the types noted and employed such terms as android anthropoid, android-gynecoid, android flat anthropoid-gynecoid, gynecoid flat etc. While these designations are interesting and descriptive it is obvious that for general clinical purposes a more simple classification is essential. I have recently suggested that such a classification can be based chiefly upon the general conformation of the superior strait as is shown in the following grouping:

1 *The female type* The normal female pelvis of other classifications. The superior strait is ovoid in shape, the transverse diameter being more than 1 centimeter longer than the anteroposterior diameter. The pelvis may be classified as large, average or small dependent upon the length of the anteroposterior diameter. If this diameter is 12 centimeters or over the pelvis is designated as large female type. If the diameter is under 10.5 centimeters it is designated as small female type. In rare instances the length of the transverse diameter may be so increased over that of the anteroposterior

diameter as to render a distinctly flattened appearance to the superior strait. In any instance therefore where the transverse diameter is longer than the anteroposterior by 3 centimeters or more such a pelvis is spoken of as flat female type. For example, the anteroposterior diameter being 9.5 centimeters with the transverse diameter 12.5 centimeters the pelvis would be designated small flat female type.

2 *The round type* The superior strait in this type has a distinctly round appearance the transverse diameter predominating in length over the anteroposterior by 1 centimeter or less. The pelvis may be classified as large, average or small, dependent upon the length of the anteroposterior diameter. If this diameter is 13 centimeters or over the pelvis is designated as large round type. If this diameter is less than 11 centimeters it is designated as small round type.

3 *The anthropoid type* The superior strait appears elongated anteroposteriorly. The anteroposterior diameter is longer than the transverse. The pelvis may be classified as large, average or small dependent upon the length of the anteroposterior diameter. If this diameter is 14 centimeters or over the pelvis is designated as large anthropoid type. If this diameter is less than 11.5 centimeters it is designated as small anthropoid type.

To differentiate readily large and small pelvis in these types we may summarize as follows:

Large pelvis

Female Type—Anteroposterior diameter of 12 centimeters or over

Round Type—Anteroposterior diameter of 13 centimeters or over

Anthropoid Type—Anteroposterior diameter of 14 centimeters or over

Small pelvis

Female Type—Anteroposterior diameter less than 10.5 centimeters

Round Type—Anteroposterior diameter less than 11.0 centimeters

Anthropoid Type—Anteroposterior diameter less than 11.5 centimeters

the external conjugate measured 17.5 centimeters with true anteroposterior diameters of 11.0 11.0 12.5 11.5 11.0 10.5 9.5 9.5. In 5 instances the external conjugate measured 17.0 centimeters with a true anteroposterior diameter of 11.0 11.0 12.0 12.5 11.5. These figures show the impossibility of establishing any true relationship between the length of the external conjugate diameter and the true anteroposterior diameter of the superior strait.

With regard to external pelvimetry of the pelvic outlet the situation is different. Here the bony points to be measured are easily palpable externally and our mensuration of the diameters of the outlet should be reasonably accurate. I believe therefore that the most practical methods of determining the dimensions of the female pelvis in the living are those of roentgen pelvimetry of the superior strait and external pelvimetry of the pelvic outlet.

Perhaps at this point a word should be said with regard to the determination of the diagonal conjugate diameter by means of vaginal touch. We have found that in primiparous patients this is usually an unsatisfactory procedure due to the rigidity of the soft parts and to the discomfort experienced by the patient. Furthermore it is obvious that in most of the round type and anthropoid type pelvis, the procedure is of little use as the fingers of the examiner are not, as a rule sufficiently long to reach the sacral promontory.

In studying the character of the labor in 100 primiparous women whose pelvis come under the classification just noted the following facts were observed:

PELVES OF THE FEMALE TYPE

Of the 49 cases presenting pelvis classified as female type (43 white, 7 colored) 39 were delivered spontaneously and 10 by operative procedures. In 7 instances the occiput entered the posterior half of the pelvis (15 per cent of vertex presentations). This occurred 3 times in the average female type, 3 times in the small flat female type and once in the small female type.

PELVES OF THE ROUND TYPE

Of the 37 cases presenting pelvis classified as round type (32 white, 5 colored) 26 were

delivered spontaneously and 11 by operative procedures. In 7 of this group (7 of 34 vertex presentations or 20 per cent) the occiput entered the posterior half of the pelvis.

PELVES OF THE ANTHROPOID TYPE

Of the 15 cases presenting pelvis classified as anthropoid type (12 white, 3 colored) 12 were delivered spontaneously and 3 by operative procedures. In 8 cases (8 of 14 vertex presentations, or 57 per cent) the occiput entered the posterior half of the pelvis.

DURATION OF LABOR

Many factors influence the duration of labor in primiparous patients, such as the strength and frequency of the uterine contractions, the size of the fetus, the malleability of the fetal head etc. However the size and shape of the pelvis is one of the important factors. While no definite conclusions can be drawn from the following data concerning the length of labor in the series in question the figures as given may be of interest:

<i>Female type series</i>	hours
Average duration of labor for the series	16½
Average duration of labor in large type	18½
Average duration of labor in small type	20½
<i>Round type series</i>	
Average duration of labor for the series	17½
Average duration of labor in large type	19½
Average duration of labor in small type	21½
<i>Anthropoid type series</i>	
Average duration of labor for the series	13½
Average duration of labor in large type	14½
Average duration of labor in small type	12½

OCCIPITOPOSTERIOR POSITIONS

In 1932 I called attention to the intimate association between occipitoposterior varieties and the transversely contracted (round and anthropoid type) pelvis, and reviewed 16 consecutive cases in which occipitoposterior positions had occurred consecutively. An analysis of these cases according to the classification given shows the types of pelvis presented:

Average anthropoid type	4
Large anthropoid type	1
Average round type	8
Small round type	2
Small female type with slight asymmetry	1

In the paper noted above the statement was made that 'transverse contractions of the

pelvic inlet, either real or relative are far more frequent than hitherto supposed and have a most important place in occipitoposterior positions." In the following year I pointed out that actual or relative shortening of the transverse diameter of the superior strait results in a limitation of space that is relatively greater in the anterior than in the posterior half of this plane and that under these circumstances it seems obvious that the occiput in its descent will enter the pelvis in its posterior half. This viewpoint was substantiated by the opinion of Caldwell and Moloy who state that "in the anthropoid type of pelvis engagement is possible only in the anteroposterior diameter as compensation exists in the posterior pelvis the anterior part of the inlet being narrow."

Several observers have pointed out that early in labor an occipitoposterior position is more common than is generally recognized. Thus Potter (3) who because of his unusual technique of delivery by version and extraction makes vaginal examinations early in labor, reports in a series of 515 cases an occipitoposterior position in 166 or 32 per cent. Danforth (2) in a recent review of 1,565 cases noted this position in 443 or 27.1 per cent. My own opinion is that in certain varieties of pelvis such as the anthropoid round, small female and flat female types the incidence of this position is very high and that the general incidence early in labor is somewhere between 35 and 50 per cent.

The incidence of occipitoposterior position in pelves of the small female type and the flat female type as noted in 4 cases of the present series deserves comment. In the former the shape of the superior strait usually approximates that seen in the small round pelvis which, I am convinced, favors occipitoposterior position while in the flat female type the abnormal projection forward of the sacral promontory which characterizes this variety unquestionably forces the occiput to occupy the posterior half of the pelvis.

The query may well be made as to why in the present series occipitoposterior position early in labor does not show greater incidence. A number of factors may explain this. In the first place these patients were delivered by the house staff whose examinations from be-

low are usually limited to rectal touch. It is obvious that many occipitoposterior positions may be thus overlooked, particularly early in labor when the cervix is but partially dilated. Secondly many patients do not enter the hospital until well advanced in labor and when seen by the examiner spontaneous internal rotation will have already taken place.

CONCLUSIONS

The present study of the pelvis in 135 primiparous women, 100 of whom have been delivered emphasizes the following

- 1 The incidence of anatomical variations of the pelvis is of frequent and significant occurrence. In this group the so called "normal" female pelvis of other classifications occurred in but 52 per cent of cases.

- 2 Because of the frequency of the incidence of anatomical variations, a simple, working classification is necessary and the one presented here is both simple and descriptive in its nomenclature.

- 3 An accurate and practical survey of the female bony pelvis should include roentgen pelvimetry of the pelvic inlet and external pelvimetry of the pelvic outlet.

- 4 The incidence of occipitoposterior position early in labor is undoubtedly greater than is generally believed. In certain of the pelvic variations such as the anthropoid type it is unusually high.

- 5 The important rôle played by the shape of the superior strait in the production of occipitoposterior position is again emphasized.

- 6 The importance of accurate pelvimetry in every primiparous woman is again demonstrated. The practice of scientific obstetrics presumes a knowledge of all the facts that are essential for the successful outcome of labor and the important part played by the size and shape of the bony pelvis needs no emphasis.

BIBLIOGRAPHY

- 1 CALDWELL, W. E. and MOLOY, H. C. *Am J Obst & Gynec* 1933, 26 470.
- 2 DANFORTH, W. C. *Ibid* 1934, 28 756.
- 3 POTTER, I. W. *The Place of Version in Obstetrics*. St. Louis, 1922 p. 127.
- 4 THOMS, H. *Am J Obst. & Gynec.*, 1932 24 50
- 5 *Idem* *Radiology* 1933, 21 125.
- 6 *Idem* *Am J Obst. & Gynec.*, 1933, 27 270.
- 7 *Idem* *J Am M Ass* 1934, 102 2075.
- 8 TURNER, W. J. *J Anat & Physiol.*, 1886 20 317

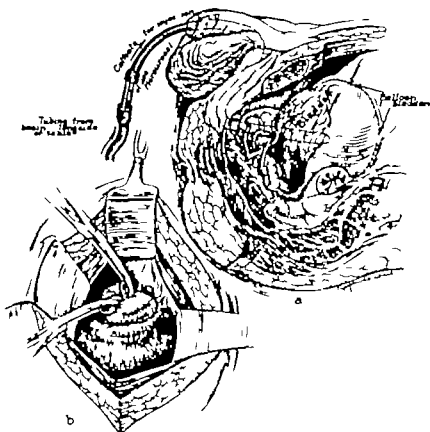


Fig. 2. Drawing to illustrate the exposure by blunt dissection of the prevesical space, anterior surface of the prostate and membranous portion of the urethra. Distention of the bladder by the balloon and splinting of the urethra by the catheter help very much in this dissection. a, Shows the general anatomical relationships with the bladder distended and the catheter in place. b, Illustrates how the membranous urethra is opened after it has been isolated and the contained catheter is clamped and divided.

Cystectomy a Method of Retroprostatoseminal Vesicuocystectomy—FRANK HINMAN

CLINICAL SURGERY

FROM THE UNIVERSITY OF CALIFORNIA HOSPITAL

CYSTECTOMY, A METHOD OF RETROPROSTATOSEMINAL VESICULOCYSTECTOMY

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I CAN find very few descriptions of the operation of cystectomy. The removal of an exstrophic bladder requires no particular technique. The removal of a malignant bladder however is a different matter. The malignant bladder should be removed intact unopened and with the least possible manipulation. Drainage of the pelvic space afterward is equally important as pointed out by the late R. C. Coffey.

There are two routes by which the bladder can be removed—the perineal and the suprapubic. The perineal route is indicated in men with carcinoma of the trigone or neck of the bladder associated with involvement of the prostate, either of which may have been primary. (The vaginal route is indicated in women with cancer of the urethra and vagina.) When this involvement is extensive and the man's pelvis is frozen with cancer the condition probably is inoperable. Such cancers can be removed completely neither suprapubically nor perineally and radical surgery should not be attempted. In less advanced conditions radical removal is possible. When involved the prostate and vesicles can be freed from the rectum more easily through the perineum than suprapubically. When the prostate and vesicles are uninvolved or only slightly so their removal with the bladder by the method to be described is much easier through the abdomen than through the perineum. Some patients with associated vesical and prostatic involvement can be operated on to advantage by a combination of the two routes freeing of the prostate and vesicles perineally and then enucleation of the bladder prostate, and vesicles as one mass suprapubically. The suprapubic route is commonly employed for cystectomy in cancer of the bladder the usual procedure being to free the fundus of peritoneum isolate the vesical arteries and ligate them and then peel the bladder from the vesicles and prostate.

The following method is indicated for those cases of primary cancer of the bladder which require total cystectomy and in which the urine has been diverted (uretero-intestinal implantation) in order that this might be done. In all cases of this type even though the neck of the bladder and the prostate are not invaded apparently the radical removal of the bladder prostate and vesicles intact will insure more completely the removal of all the cancer. The method is retrograde as compared to the suprapubic procedure in common use and aside from certain advantages of technique, has the additional advantage of the least possible manipulation of the bladder.

Description of the method of retrocystectomy. The bladder is washed out and left empty. A special balloon catheter (Fig. 1) is passed well up into the bladder 200 cubic centimeters of mercurousal (or air if preferred) is injected into the balloon and the catheter is connected with tubing which is clamped off in a basin alongside the table so

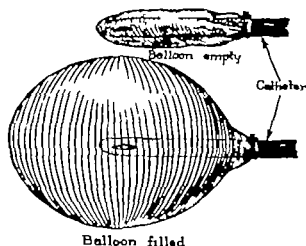


Fig. 1. Drawing of a home-made catheter-balloon. A finger cot or the finger of a surgeon's glove is tied over the end of a No. 22 or 24 soft rubber urethral catheter.

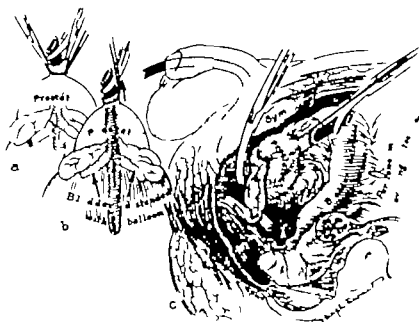


Fig. 3. Illustrates how the balloon and catheter are used for traction. a, Urethral and prostatic tissues tied to catheter by circular ligature of heavy silk. b, Shows how traction on clamp and ligature lifts the balloon and neck of the bladder. c, Shows how the prostate and vesicles can be peeled back by blunt dissection when traction is made on the catheter and balloon.

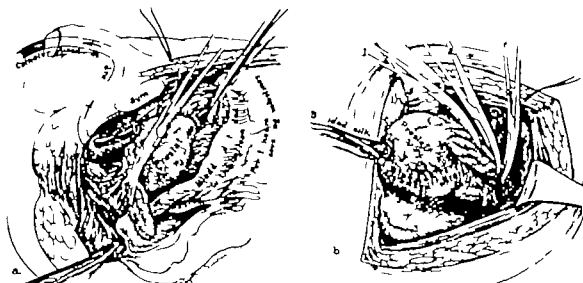


Fig. 4. Drawing which illustrates the complete freeing of the prostate and vesicles. a, View from the side. The vas and vessels on the left side have been clamped and divided. b, View from above. The clamps (No. 1) have been placed on the vesical vessels of the right side. Clamp No. 2 is on the vas.

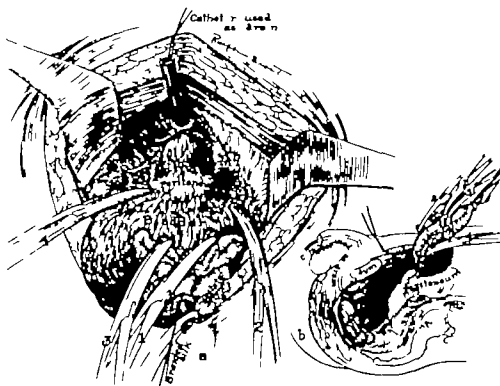


Fig 5 Drawing which illustrates the bladder completely isolated except for peritoneal and urachal attachments a, View from above showing the four clamps in place on the specimen and the corresponding partner removed after the vasa and vessels had been ligated *en masse* as shown in the depths of the field b Side view showing the only remaining attachment of the bladder to the urachus and neighboring peritoneum.

that a nurse can empty or fill the balloon (when the surgeon desires) and thus collapse or distend the bladder

The suprapubic incision need not be long (4 inches) The long scar of the previous operation (ureteral implantation) is excised for about half its length. The fascia and muscles are divided in the area of the scar down to the prevesical fat. (Care is taken not to open into the peritoneal cavity)

The space of Retzius is opened by blunt dissection with the finger, exposing the anterior surface of the prostate and bladder The lower anterolateral wall of the bladder is freed similarly By dissecting under the pubic arch, the apex of the prostate is localized (There should be no bleeding) Following the capsular surface of the prostate at the apex around each side enables one to free completely and encircle with the finger the membranous portion of the urethra. This must be done carefully, well up under the symphysis and at the apex of the prostate because the rectum may be perforated easily by the tip of a finger forced behind the prostate in the wrong line of cleavage The catheter outlines the urethra and aids in making this dissection When the apex of the prostate and the adjacent portion of

the membranous urethra are free so that they can be encircled with the finger the urethra (with the catheter in it) is doubly clamped and then divided (as is the catheter) between the clamps (Fig 2)

The clamp on the distal end is replaced by a braided silk suture by which this cut end of the catheter can be pulled well into the pelvis to serve after being perforated in a few places as a drainage tube after the bladder has been removed (Note discussion of this point under drainage.)

The clamp on the proximal end attached to the balloon is used for traction and in order that this purpose be fully accomplished, the urethral tissues and apex of the prostate are pulled up on the catheter by clamps on each side and anchored to the catheter by a circular ligature of heavy silk (Fig 3 a), the ends of which are tied to the clamp on the catheter so that the two together give good traction (Fig 3 b and c)

In the plane of separation of the fascia of Denonviller, just as in perineal prostatectomy, the prostate can be peeled from the rectum to the area of attachment of the seminal vesicle and vas on each side. The fascial layer covering the right vesicle is incised and this vesicle is freed and delivered The right vas and its vessels are isolated



Fig. 6. Photograph of prostate, vesicles and bladder with balloon catheter in place just as they were removed at operation intact and unopened.

doubly clamped and divided between the clamps (Fig. 4).

The right vascular pedicle of the bladder with the ureter now is isolated by blunt finger dissection and is divided *en masse* between the clamps. The left vas and vesicle and the left vascular pedicle and ureter are clamped and divided similarly. This leaves all the blood vessels which supplied the bladder in the four clamps. The pedicle in the distal one of each pair of clamps is

ligated and the clamp is removed. The proximal clamps are left on (Fig. 5).

The bladder now is attached only to the peritoneum and urachus. The former can be stripped off from below upward with moist gauze, to the point of the attachment of the urachus which is clamped and divided (Fig. 5) completely freeing the unopened bladder. In case the peritoneum is adherent to the bladder because of cancer or inflammation an elliptical area of peritoneum around the site of adhesions can be removed with the bladder and this opening into the peritoneal cavity can be closed without risk of contamination since the bladder has been left intact and unopened.

Drainage of the pelvic cavity left by the removal of the prostate vesicles and bladder should be thorough. Otherwise an abscess may develop in a blind pocket somewhere and lead to septicæmia, as happened in one of my patients. Once the urethral catheter which has been left for drainage (Fig. 5) has been removed, it should not be reinserted. I am not sure that leaving this catheter in originally is not a mistake. It might be preferable to close tightly by suture the open end of the urethra and rely altogether upon supra pubic drains. A perineal drain can be placed easily and gives the advantage of dependent as well as through and through drainage. Subsequent contamination of the pelvic dead space from the urethra or by way of it is likely after the catheter has been removed. This seems to be what happened in the patient just mentioned who developed septicæmia. This man of 72 was in excellent condition for 2 weeks after cystectomy and was up and about after the eighth day. An abscess formed in the pelvis extraperitoneally about this time and he died of septicæmia 3 weeks after operation. Autopsy showed that the cancer had been radically removed. The specimen is shown in Figure 6.

TRANSPERITONEAL NEPHRECTOMY FOR MALIGNANT TUMORS OF THE KIDNEY

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WITHIN the past year or two our attitude toward malignant renal neoplasms has changed. A new suggestion of hopefulness has been introduced. This is because we have learned that massive renal tumors can be made operable by deep roentgen ray therapy. In our experience this applies generally both to Grawitz hypernephromata and Wilms embryomata, and these constitute the majority of renal neoplasms. We have discovered also that other tumors of unusual and bizarre morphology such as cystic carcinoma may respond in a manner which makes their pre-operative irradiation worth while.

The effects of irradiation on the gross and histological characteristics of these tumors and the concomitant physical benefit to the patient have been reported by us elsewhere. Waters, Lewis and Frountz likewise have presented their experience and our clinical conclusions and recommendations coincide.

The salient point of these studies is that the operability of massive renal neoplasms has been vastly increased and the operative mortality reduced. Thus by pre-operative irradiation a ray sensitive tumor which fills three-fourths of the abdomen may be so reduced that it is hardly palpable. In many instances with the shrinking of the tumor the hæmaturia ceases or becomes negligible. During the 3 or 4 weeks required for the course of pre-operative irradiation more over we have an excellent opportunity actually to accomplish something in building up the physical condition and increasing the resistance of these patients. The disappearance of the abdominal mass and the cessation of hæmaturia makes this possible. Consequently in many cases by the time the course of irradiation is completed it is found that the patient may be in fairly good physical condition and the tumor may be safely operable.

It is thus evident that we have entirely revised our pre-operative regimen since we have discovered the value of pre-operative irradiation. Now we have certain definite objects in view and in the majority of instances have some hope of attaining them. Whenever we are successful a great deal of the dread and frightfulness that formerly attended the removal of big malignant renal tumors disappears. In these cases we approach

the operation with a feeling of hopefulness which was unknown two years ago.

THE OPERATION

The final result depends upon one thing—the successful removal of the tumor for we have seen no instance in which radium or the roentgen ray has entirely eliminated a large mass. Now that we have found a means of increasing the operability of these tumors the opportunity and responsibility of the surgeon have become even more significant. For this reason it is imperative that we should review the operative technique of nephrectomy to see whether it fulfills the demands of our new opportunity.

The surgical principle of the operation. In operating upon a renal tumor we have certain very definite objectives. Perhaps we may more clearly realize their importance if we consider for a moment the general pathological characteristics of these tumors.

In the first place they are made up of a mass of friable malignant tissue which is in intimate contact with vascular spaces. At times parts of the tumor actually protrude into the blood stream within a capillary or a large venous trunk. In many types, moreover this tissue is characteristically transplantable and if bits of it are spilled in the operative wound, they grow like weeds. These tumors are also highly vascular and often have abnormally placed blood vessels. They are frequently adherent, grow very large and have thin delicate capsules. These are some of the factors that in the past have made the surgery of renal tumors almost a hopeless proposition. It is for these reasons that nephrectomy has so frequently been followed by a local recurrence and a shower of metastases.

On the contrary, however, these tumors have certain characteristics that make them amenable to treatment. In the first place they seem to metastasize late for the majority of cases show no secondary growths when they reach the surgeon. Then again local invasion is rather uncommon, for the tumor usually remains within its capsule even though it may fill the whole flank. Also most of these tumors are highly sensitive to the roentgen ray and will shrink like magic if they are treated intensively. They can moreover be

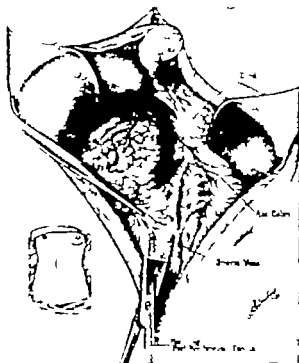


Fig. 1 The landmarks and exposure in transperitoneal nephrectomy. The illustration shows the right side, which is more complicated than the left. The abdominal incision must be large and the patient completely relaxed. The posterior peritoneum is incised at some distance from the kidney and the colon is an avascular spot. The mobilization of the peritoneum is continued carefully until one gets an exposure like that shown in Figure 2.

recognized with accuracy by cystoscopic and urographic study. These factors are distinctly favorable and it is only by taking full advantage of them that we have any chance whatever of removing these tumors successfully.

With this picture in mind, it is not hard to formulate an ideal nephrectomy. Such a procedure would allow us to isolate the tumor from its vascular connections before handling the friable mass. By so doing one would avoid massaging particles of the tumor into the blood stream. This would minimize the chance of metastasis. The ideal approach would also give us such wide exposure that we could see the entire blood supply including aberrant vessels, thus lessening the risk of hemorrhage. Also it would furnish enough room to permit the removal of the entire mass intact without rupturing its capsule. This would tend to prevent local recurrence. How do our present methods of performing nephrectomy meet these demands?

There are two available types of operation: the lumbar or extraperitoneal, and the abdominal or

transperitoneal. Of these, the lumbar is by far the most generally used, not only for renal tumors but for all operations on the kidney. Undoubtedly, we all agree that it is the rational method of attacking almost all surgical problems of the kidney because it is extraperitoneal, avoids unnecessary shock and minimizes the chance of peritonitis. But is it the method of choice in operating upon renal tumors? Does it meet the requirements which we must fulfill if we would remove these neoplasms successfully?

Clinical experience and anatomical studies indicate that lumbar nephrectomy violates every one of these principles. Lumbar nephrectomy compels one to attack the tumor before he controls its blood supply. By this approach, the mass must be widely mobilized and manipulated before the renal pedicle can be seen or ligated. Aberrant vessels are often not recognized until they bleed because they lie on the median side of the mass. The last structure to be seen and controlled is the vital renal pedicle whereas it should be the first. The excessive manipulation required by lumbar nephrectomy has in the past resulted in the operative rupture of one-third of these tumors. This immediately makes the prognosis practically hopeless. Furthermore in many of the extra peritoneal nephrectomies, the peritoneal cavity is opened more or less widely although unintentionally thus immediately cancelling one of the benefits of this particular approach. Our records of operative mortality and end results show that, even when dealing with small tumors, lumbar nephrectomy has fallen far short of the objects we seek.

Fortunately it is not the only procedure at our disposal. The alternate operation is transperitoneal nephrectomy.

The advantages of transperitoneal nephrectomy. These are definite. In the first place the generous abdominal incision enables one to see the tumor clearly and to expose and ligate the renal vessels before one handles or moves the malignant mass. Aberrant vessels can be controlled because one can see the entire flank. Furthermore, the exposure allows one to remove not only the mass and the kidney intact, but also the surrounding tissues, the capsule of Gerota, the perirenal fat and areolar tissue and as much of the ureter as one wishes. In theory therefore the operation is based on sound principles of surgery and pathology.

Furthermore, these principles are not new or radical. They have been advocated for many years. In 1905 Walker recommended transperitoneal ligation of the renal pedicle as the first step preliminary to nephrectomy by the lumbar

route. At that time he stated that he had never seen or heard of transperitoneal nephrectomy. Nine years later, in 1914 J M T Finney deliberately planned and performed transperitoneal nephrectomy for a small hypernephroma and the patient is well today. In 1921 Quinby stated that tumors of the kidney should be removed transperitoneally although he described a surgical technique which we believe to be unnecessarily complicated and which we shall discuss later. We do not know whether he still uses that technique. Most of the recent textbooks on general surgery state without reservation that renal tumors should be removed transperitoneally.

In view of the widespread approval of the principle of transperitoneal nephrectomy and in view of the known shortcomings of lumbar nephrectomy, there must be some very real explanation for the fact that lumbar nephrectomy continues to be the method which is most commonly used.

The chief reason is probably the question of operative technique. Although transperitoneal nephrectomy is recommended in practically all modern surgical texts it is described in very few of them, and in none is there an illustration which would in any way help one to visualize the steps of the operation. Furthermore, the technique which is often recommended is unnecessarily complicated and presupposes an anatomical familiarity with the upper abdomen which is possessed by practically no urologists, very few gynecologists and not all general surgeons. The method often recommended involves the identification and mobilization of the duodenum, the jejunum or the ligament of Treitz, and eventually by the use of these landmarks the localization and ligation of the renal pedicle. Most of the renal surgery in this country is done by urologists and gynecologists, and to men in these specialties the upper abdomen is rather unfamiliar ground. Obviously, an operation thus designed could never be generally adopted. Indeed it would be hazardous for the average gynecologist or urologist to attempt it. Realizing this unsatisfactory state of affairs, when Kelly and Burnam wrote their classic two volume text on *Diseases of the Kidneys, Ureters and Bladder* in 1915 they dismissed the whole subject of transperitoneal nephrectomy in one short paragraph, condemning the procedure unceremoniously. We hold the same opinion of the highly complicated operations that are often recommended. As we shall show however these technical complications are entirely needless because transperitoneal nephrectomy can be made a very simple and safe operation.

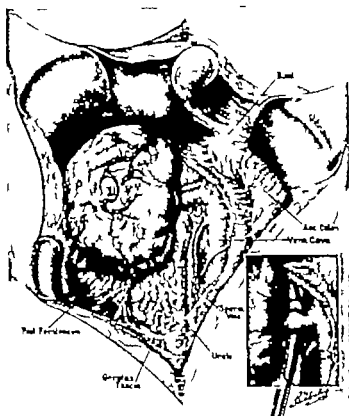


Fig. 3 The exposure of the renal pedicle. The mobilization of the peritoneum carries out of the operative field the colon and duodenum and brings one directly to the vena cava and the renal vessels. The artist does not exaggerate the clearness of the view. By this technique one obtains complete control of the blood supply of the renal neoplasm with very little manipulation. It may not be necessary to expose the vena cava. With such exposure one can devote his attention to the removal of the tumor with a wide margin of surrounding tissue, the control of the blood supply is usually a simple problem. One can also remove as much of the ureter as is necessary.

Less valid is the objection that the operation involves opening the peritoneal cavity. If, in this instance we had the choice between two equally satisfactory operations, one extraperitoneal and the other intraperitoneal it would certainly be good judgment to use the extraperitoneal route. But in this case the extraperitoneal approach is fundamentally faulty whereas the transperitoneal route gives us at least an opportunity to handle the surgical problem in a safe and scientific manner. The experienced surgeon would much prefer a wide transperitoneal view of a dangerous situation to a cramped extraperitoneal peep at it.

We do not underestimate the fact that a transperitoneal operation introduces factors which one need not consider when the peritoneum is not opened. We dismiss the question of peritonitis because we do not recommend this operation for infected kidneys, except in rare situations. For the transperitoneal operation, however, the

One can waste a great deal of time and increase the surgical shock by trying to pack away the intestines before relaxation is complete.

Step 2 The exposure of the tumor As the illustrations show the operator works directly across the peritoneal cavity. The hyperextension of the back however, brings the lumbar wall nearer to the surface, and the big incision makes it entirely unnecessary to work in a hole. In fact one should feel a distinct sense of roominess which gives one confidence and ease.

After the intestines have been pushed into the opposite half of the abdomen one is brought immediately to the posterior abdominal wall. The large intestine is seen coursing vertically and in the renal fossa one sees the bulging caused by the kidney mass. These are the landmarks.

Step 3 The layer of posterior peritoneum is now incised. This is also a very simple step. The incision in the posterior peritoneum should be made at least 2.5 centimeters from the lateral margin of the large bowel so that one will not injure it and have a wide flap of peritoneum for easy approximation afterward.

I find that it is much easier to incise this layer of peritoneum if one mobilizes it before cutting it. One picks up the peritoneum at a clear spot nicks it with a knife and then by inserting the closed scissors into this opening mobilizes the peritoneum in the line of the desired incision. This step is illustrated.

The peritoneum is thus mobilized and cut well above the flexure of the large intestine. The large intestine is then gently pushed medially and held back by the gauze and retractors which are already in place. The peritoneum is also pushed away from the region of the renal pedicle and the kidney. The duodenum goes with the peritoneum and ascending colon. If by chance the kidney tumor and the peritoneum are intimately adherent one can leave a wide patch of peritoneum on the kidney and remove it with the tumor. When operating upon the left kidney one does not have to think of the duodenum.

The elevation of the posterior peritoneum brings one down directly to the retroperitoneal mass. The kidney is usually visible. The renal pedicle and pelvis are hidden under a layer of loose fat. In thin persons, the ureter can often be seen. It can almost always be picked up by rolling the loose areolar tissue and fat between the fingers. It can thus be exposed easily and if traced upward will lead directly to the renal pedicle. It is often helpful to expose the ureter to the kidney at this stage because this procedure aids in exposing and mobilizing the renal vessels.

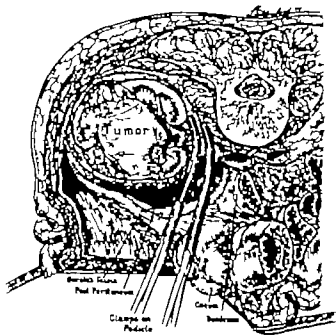


Fig. 4. A cross section view of transperitoneal nephrectomy. This shows how completely the large intestine and the duodenum are eliminated from the operative field by this technique. We make it a practice to remove Gerota's perirenal fascia with the tumor.

Step 4 Ligation of the renal pedicle This is the most important step in the whole operation. In order to expose the renal vessels clearly it may often be advantageous to mobilize the lower pole of the kidney. This can be done gently without moving the kidney in its retroperitoneal bed. It is always necessary to push the peritoneum and all other structures away from the region of the renal pedicle before attempting to isolate it. If one follows this simple rule he will never have to fear injuring the duodenum or any other adjacent structure. In all cases, the operator should get a clear view of the renal artery and veins also he will often see the aorta and vena cava as well.

The renal vessels are usually buried or covered by a layer of fat. They can be located in several ways. By palpation one can feel their pulsation. Their relation to the renal hilum usually points them out. Then again the ureter leads directly to the renal pelvis.

As a rule there is no difficulty whatever in locating not only the renal vessels but also aberrant arteries and the ovarian or spermatic vein. Before clamping and controlling the renal artery and veins, it is always wise to expose them thoroughly removing the fat and areolar tissue by which they are concealed. They should be elevated from the bed in which they lie so that a ligature may be passed around them. This procedure is done carefully and under full vision.

Every surgeon will have his own particular method of preference in handling and isolating the renal pedicle and he will probably vary it with changing demands.

Step 5. Removal of the tumor. It is essential that there should be no back bleeding from the tumor or kidney at any time as this blood will probably contain cells of the tumor. Local recurrence is very likely if this occurs.

The removal of the tumor is usually a fairly simple matter after the blood vessels have been ligated and cut. We have not observed any unusual adhesions as the result of pre-operative irradiation. In fact the irradiated tumors are usually harder more compact have a thicker capsule and are definitely less friable and vascular than tumors which are not irradiated. We try to remove all of the perirenal tissue possible, including the perirenal fat, Gerota's capsule (the perirenal fascia) a long strip of the ureter and all the areolar tissue we can safely take away.

Step 6. Closure. The posterior layer of peritoneum is closed tight by a continuous suture of plain catgut. If drainage is necessary it can be provided through a stab wound extraperitoneally in the flank. We did not drain our last two transperitoneal nephrectomies, and the wounds healed cleanly.

The operation which we have described is usually done very easily in a little more than 1 hour, requires no pulling or tugging, entails very little shock, and in our opinion, is much less risky than a lumbar nephrectomy for tumor.

CONCLUSIONS

We have described and illustrated the steps of a simple method of performing transperitoneal nephrectomy. We present this because of the current opinion that transperitoneal nephrectomy is a dangerous and complicated operation and because this particular technique has not been illustrated in the available literature. It is our

opinion and the opinion of many other surgeons that transperitoneal nephrectomy is far safer than lumbar nephrectomy for the removal of renal tumors.

We present this as part of a study of renal tumors. In another communication we outlined our experience with the pre-operative irradiation of malignant renal tumors. We have found that pre-operative irradiation makes many of these big tumors operable by reducing their size remarkably. It has also been our experience that in transperitoneal nephrectomy we have a surgical technique which gives us a chance to remove these tumors with fair safety and with a minimum likelihood of rupturing the mass. We cannot venture an opinion as to the effect this method of treatment will have on the number of permanent cures. We do know however that the first step is the successful removal of the tumor and in this communication we have outlined two procedures which have helped us to accomplish this step.

BIBLIOGRAPHY

1. CIRCUMILL, EDWARD D. and McNEILL, DONALD. The reduction in vital capacity following operation. *Surg. Gynec. & Obst.* 1927, 44, 483-488.
2. EDEY, J. M. T. Personal communication.
3. KELLY, HOWARD A. and BURNHAM, CURTIS F. *Diseases of the Kidneys, Ureters, and Bladder*. Vol. 1, p. 384. New York: D. Appleton & Co. 1914.
4. OVERHOLT, RICHARD. Air in the peritoneal cavity: its effect on the position and activity of the diaphragm. *Arch. Surg.* 1930, 31, 1282-1290.
5. QUINBY, W. M. C. The transperitoneal approach to the kidney: its indications and limitations. *J. Urol.* 1921, 5, 133-147.
6. WALKER, GEORGE. Transperitoneal ligation of the renal vessels. *J. Am. M. Ass.* 905, 45, 1647.
7. WATERS, CHARLES A., LEWIS, L. G., and FROVITZ, W. A. Radiation therapy of renal cortical neoplasms with special reference to pre-operative irradiation. *South. M. J.* 1934, 27, 290-299.
8. WHARTON, LAWRENCE R. The pre-operative irradiation of massive tumors of the kidney: A clinical and pathological study. *Arch. Surg.* 1935, 30, 35-5.

LYMPHANGIOMATA OF THE GREAT OMENTUM¹

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ABDOMINAL tumors are not common in children. The most frequent and generally recognized types at this age are neoplasms involving the kidney and ovary. Among the rarer forms are the lymphangiomas of the great omentum. These tumors occur very infrequently and the cases are somewhat of a surgical and pathological curiosity. Sporadic isolated case reports appear from time to time. Stillman reported 2 cases in 1911, and included in his paper summaries of 19 other cases which had been published up to date. We have verified his sources and reviewed the literature since 1911 with reference to 2 cases recently observed at the Children's Memorial Hospital, and have found reports of 30 other cases including 5 reported before 1911 which were omitted from Stillman's group. The total number of cases, including our own, is 53, a group which is sufficiently large to permit some statistical discussion with a view toward outlining the significant features of the general disease picture.

Our interest in this subject was stimulated by 2 patients who came under our observation with the following case histories:

CASE 1. L. K., a Polish girl, 5 years of age, entered the Children's Memorial Hospital, April 7, 1931. About 3 years previous, the mother had noted that the child's abdomen was gradually becoming larger. During the next 4 months the child seemed rather listless at home, played very little and had a poor appetite, but did not complain of any pain. The abdominal swelling seemed to fluctuate a little in size during this period. For the next 16 months up to the time of admission, the child's condition had been rather stationary with no change in the size of the abdominal tumor or in the listless appearance of the child. However about 5 weeks before her entrance into the hospital she began to complain of abdominal pain occurring mostly at night and causing her to cry out. There was no nausea during this period, but her mother thought that occasionally the child showed a small amount of fever.

During the two previous years she had had chicken-pox, whooping cough and measles without complications. Her history otherwise was negative.

The findings on physical examination showed nothing abnormal except the abdomen which was quite prominent and had a doughy resistance but seemed to be tympanitic throughout. In the right lower quadrant in the region of McBurney's point a discrete, movable mass about the size of an egg could be palpated. It was not tender and could be moved around for a distance of about 3 inches. The mass felt distinctly like a cystic tumor.

An examination of the urine showed nothing abnormal, and a tuberculin skin test was negative. An examination of the blood showed hemoglobin of 55 per cent, red blood cells 3,360,000, and white cells 11,400 of which 50 per cent

were polymorphonuclear leucocytes and 48 per cent lymphocytes.

During her period of observation the child developed scarlet fever complicated by the finding of diphtheria organisms in her throat during convalescence. It was necessary to remove the child's tonsils before a negative throat culture could be obtained. After that the child seemed to be in good condition so it was decided to investigate the tumor mass in the abdomen by means of an exploratory laparotomy.

Operation. July 18, 1931, under ether anesthesia the abdomen was opened by a midline incision. It was found that the mass that had been palpated before operation, was attached to and part of a large cystic tumor which occupied most of the great omentum. The mass was easily delivered from the abdomen except for the part which was attached to the transverse colon near the splenic flexure by a broad pedicle. This was severed as close as possible to the colon and the tumor removed. For fear of interfering with the blood supply of the colon, a few small cysts were left in the pedicle when it was ligated. The abdomen was closed and the child went on to an uneventful recovery. She was discharged from the hospital in good condition on August 2, 1931.

Pathological examination. Report by Dr. Irving J. Wolman (Fig. 1). The specimen is a large irregular tumor mass weighing about 1,500 grams and measuring 30 by 30 by 8 centimeters when completely spread out. It consists of numerous confluent rounded cysts situated within the substance of the great omentum. The cysts vary in size from being just visible up to 13 by 9 by 6 centimeters which is the measurement of the largest. The cysts have rounded contour and many are spherical, others seem to have anastomosed and their shape is more irregular. There are numerous constrictions and grooves on their surfaces. Sometimes they seem to anastomose with each other through a cluster of smaller intermediate lying cysts. Their wall is thin and pale, often membranous, and shows dilated narrow widely separated blood vessels within it. The outer surface has a smooth, serous appearance. Strands of delicate omental fatty areolar tissue run among the nodules binding them together. The cyst content consists of colorless or gray semi-solid jelly like fluid. It varies in consistency and opacity in the various chambers. After preservation in formaldehyde these contents assume a white coagulated appearance. In several cysts, the capsule is thick white, and hyaline, measuring as much as 2 millimeters in thickness. The lining is pale and smooth, but there are patches of coarse, wrinkling and elevated trabeculations. No blood or large cellular masses are noted within the cysts. They extend all through the omentum some being present at the cut edge. The gross appearance is that of a cystic lymphangioma of the omentum.

Histological note (Fig. 2). Five sections were examined. The cyst contents stain a homogeneous pale granular matter. Their walls are formed of hyaline, relatively acellular fibrous tissue in the form of a capsule. The wall of some cysts is more compact and thicker than others. Occasional small round cells occurring singly or in small groups are noted within the interstices, and also some large mononuclear cells with basophilic homogeneous cytoplasm and eccentric hyperchromatic nuclei. There is no

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Fig. 3 Unilocular cystic lymphangioma of the great omentum

TABLE I—AGE OF PATIENTS AT ONSET OF SYMPTOMS

	Cases
Infancy	11
to 5 years	18
6 to 10 years	5
"Child"	1
10-20	5
20-30	5
31-40	2
41-50	3
51-60	0
"Adult"	3
Patients under 10 years	35
Patients over 10 years	8

It is noticeable that 35 or approximately 66 per cent, of the cases were in children under 11 years of age. In regard to the character of the lymphangiomata, 25 were unilocular, 25 multilocular, and in only 3 cases were multiple tumors present.

The cyst in most cases rested entirely free in the abdominal cavity except for the pedicle attachment. In 15 cases adhesions were found between the cyst and other structures in 6 instances to the abdominal wall in 6 to the uterus and in 1 to the intestine, pancreas, and inguinal canal, respectively. The tumors graded in size from the very smallest to cysts that were recorded as containing 16 quarts or weighing from 40 to 60 pounds.

The most frequent pathological complication was twisting of the pedicle of the cyst that occurred in 6 cases. Rupture of the cyst occurred in 1 case and hemorrhage into the cyst in another.

The clinical features associated with these lymphangiomata are not characteristic. Symptoms are usually slow in developing and are of long duration, the average time being 2.3 years. In a general way these cases may be grouped clinically as shown in Table II.

TABLE II—CLINICAL FEATURES OF LYMPHANGIOMATA OF THE GREAT OMENTUM

	Cases
Group 1—Symptoms due to the size of the tumor	42
A—Diffuse abdominal swelling	31
B—Localized palpable mass	9
C—Abdominal pain and distress	11
Group 2—Symptoms produced by twisting of pedicle or rupture of cyst. Clinical picture closely simulates that of appendicitis or twist of pedicle of an ovarian cyst	6
Group 3—No symptoms—Cyst discovered incidentally during abdominal operation	5

1. In the first group symptoms are due to the size of the tumor. A very large majority of the cases in this series, 42 of 53, were in this group. The most frequent clinical finding in these patients was a diffuse abdominal swelling which was present in 31. The swelling in many instances showed signs of fluid which appeared to be cystic in some cases, but was regarded as ascitic in others. The principal symptoms associated with the abdominal swellings, when they become large, were general weakness which was evident in 5 patients, dyspnea on exercise which was exhibited by 6 patients, and loss of weight which occurred in 4 patients.

Instead of a diffuse abdominal swelling a palpable local lump was present in 9 cases. In our first case, the size of the palpable mass gave a very erroneous idea of the actual size of the cystic mass. Sensory symptoms were noticeably absent in most cases in this group, but abdominal pain and distress were described by 11 patients. The pain was usually of a dull character and was present at irregular periods. Loss of appetite with or without nausea and vomiting was not infrequent.

2. The second group, in which the symptoms were produced by a twisting of the pedicle of the cyst consisted of only 6 cases. In contrast to the larger previous group the clinical features were all indicative of an acute abdominal inflammation resembling appendicitis, or the torsion of the pedicle of an ovarian cyst.

The clinical picture usually began with abdominal pain associated with nausea and vomiting. Abdominal tenderness, and sometimes rigidity with moderate fever and leucocytosis were present. In one of the cases of this group the symptoms were due to a traumatic rupture of the cyst.

3. The third group was made up of 5 cases in which there were no symptoms and the cysts were discovered incidentally during operation for other abdominal conditions, usually uterine myomata.

The indefinite and meager clinical features and the rarity of these omental cysts tend to make the diagnosis somewhat difficult. It is not strange therefore, that in this group of 53 cases the correct pre-operative diagnosis was made in only 1 instance. A diagnostic abdominal puncture was made in 13 cases, but it did not seem to be of much assistance. It was employed in our second case and the finding of bloody fluid only served to obscure the diagnosis. The fact that 66 per cent of the cases reported have been in the age of childhood should be emphasized, as well as the comparatively symptomless character of the slow growing abdominal mass.

Tuberculous peritonitis will often be confusing unless it can be ruled out by a negative tuberculin reaction. Ovarian cysts which are not confined to the pelvis will be hard to differentiate. Mesenteric cysts, uterine myomata and congenital cysts of the liver will have to be considered. The cases with acute symptoms due to a twisted pedicle simulate appendicitis or torsion of an ovarian cyst so closely that differentiation will probably be impossible.

Surgical treatment was employed in all of the cases in this series except the first one on record which was reported in 1851 by Gairdner who found an omental cyst at autopsy. Aside from the fact that some of the patients are very young the operative procedure is relatively simple. The cyst is exposed, freed from adhesions, and removed in the same manner as an ovarian cyst.

The surgical results in general were very satisfactory. Omental cysts are benign tumors and do not tend to recur after removal. The operative mortality in this series was very low as there were only 2 deaths in the 53 cases.

SUMMARY OF CASES COLLECTED FROM THE LITERATURE

In 1911 Stillman reported 2 cases of true lymphatic cysts of the omentum and collected 19 others from the literature. These included the unilocular solitary type of cyst as well as the multilocular lymphangiomas, and were reported by Gairdner (1851) Gooding (1887), Spencer Wells (1890) Erdheim (1896), Marian (1896), Hearn (1897) Braithwaite (1898) Jacobi (1901), Marsh and Monsarratt (1901), Schramm (1903), Boyd (1903), Schwarzenberger (1894) Young (1905) Matthews (1905) Fort (1907) Wakefield (1907) Rodman (1909) Seefisch (1909) and Gifford (1910). Details concerning the above tumors are readily available in Stillman's comprehensive article. We have reviewed the more recent literature to supplement the above list

and we have found reports of 30 more cases, not including the 2 cases of our own. The 30 cases abstracted are as follows

CASE 22. Reported by Brandt. Patient was 15 years of age sex not stated. The patient had a freely movable abdominal tumor reaching to the navel, and the diagnosis of omental cyst was made. Operation disclosed a large, single cyst containing 2 liters of dark fluid. The wall was not lined with endothelium. Recovery was uneventful.

CASE 23. Reported by Dewitsky and Morosow. In a male, 3 years of age, an abdominal swelling was noted in the first year of life. Physical examination showed an enlarged abdomen with circumscription at navel of 64 centimeters and a fluid wave and dullness to percussion. There had been an intermittent diarrhea since 1 month of age. The clinical diagnosis of tuberculous peritonitis was made. Operation exposed a large abdominal cyst containing 4 liters of chocolate colored fluid which was evacuated. Repair of a congenital inguinal hernia was also done. Death occurred the next day. At autopsy the large cyst and numerous smaller cysts were found to have an endothelial lining, the omental lymphatics were dilated.

CASE 24. Reported by Da Costa. A thin walled unilocular cyst containing dark colored fluid and having a fibrous lining was removed from a male child.

CASE 25. Reported by E. M. Hasbrouck. The patient, 50 years of age, colored, had an abdominal swelling which had begun 1 year previously and gradually increased until the abdomen became enormous. Dyspnea, constipation, and frequent micturition resulted. At operation a large, thick walled cyst containing a blood clot, and with many small cysts in its wall, was found. This was estimated to weigh about 40 pounds. It was situated in the omentum between the stomach and transverse colon. Microscopically the cells appeared epithelium like in structure with a disposition to arrange themselves in columns encircling the blood vessels. Hasbrouck considered the specimen to be an endothelioma. However, it was later restudied in the laboratory of Dr. J. C. Bloodgood (according to McDonald) and was there considered a benign lymphogenous cyst.

CASE 26. Reported by N. M. Kakuschkin. The patient, a female, 28 years of age, had a history of gonorrhea. An abdominal tumor had been noted for 5 months. A pre-operative diagnosis of omental or ovarian cyst was made. Operation showed many small cysts in the omentum, which was bound to the internal genitalia by numerous fibrous adhesions. These cysts were lined with flat mesothelial cells, which occasionally assumed a cuboidal appearance. Evidences of hemorrhage were found in a few of the chambers.

CASE 27. Reported by Markoe and McPherson. Female adult. In the course of a hospital stay for purposes of confinement, an easily movable, painless tumor was palpated just above the fundus of the uterus, between the ensiform cartilage and umbilicus. After delivery a second tender fixed mass was palpated in the left broad ligament region. At operation two separate and distinct cysts were removed from the omentum. The larger, the size of a grapefruit, lay in the right side of the pelvis, displacing and adherent to the uterus. The other, the size of an orange, was adherent to the appendix. The cysts were filled with serous fluid, had smooth fibrous walls, and were subdivided by connective tissue septa. No endothelial or epithelial lining was recognizable. Certain areas had undergone calcareous degeneration.

CASE 28. Reported by Markoe and McPherson. Female, 27 years of age. A tumor in the right inguinal region had

been present since birth. This was found to be the size of a grapefruit, slightly fluctuant, and gave no impulse on coughing. It was thought to be an inguinal hernia. On cutting down over the mass the operator found it to be a thin walled omental cyst which had prolapsed through the inguinal canal and was attached by a long pedicle. Through an abdominal incision the pedicle was tied off and the cyst was easily removed by way of the inguinal incision. Recovery was uneventful. The cyst wall was found composed of connective tissue principally with some round cell infiltration indicating acute inflammation.

CASE 29. Reported by Frank. Female, 30 years of age. The patient had been wearing a pessary for 10 months because of uterine prolapse. Seven months ago she noticed an enlargement in the pelvis which had been gradually increasing in size. Her bowels were constipated. On examination a cystic abdominal tumor was palpable in the region of the navel, and there was a protrusion of the abdomen about the size of two fists. Per vaginam a number of cystic nodules could be felt, filling up the entire pelvis. A diagnosis of ovarian cystomata was made.

At operation a large multilocular cystic formation of the omentum was removed. In addition, numerous small similar cysts were scattered on all the peritoneal surfaces, the caecum, small gut, mesentery, uterus, broad ligament, tubes, and ovaries. Each cyst was easily separated from its neighbor and from its attachments. Their walls were thin and they contained clear serum. A rather large cyst was found in the groin fascia, external to the external inguinal ring. All the cysts had an identical microscopic appearance, and were lymphangiomatous in character.

CASE 30. Reported by Funk. Female, aged 7 years. An abdominal swelling was first noted 3 years earlier. The abdomen became the size of a 9 months pregnancy and produced symptoms on pressure. Operation showed a single, large cyst within the substance of the omentum, which was distended and then dissected. Its wall was thin, regular in thickness, and consisted of fibrous tissue. Internal to this capsule was a single row of flat cells. Recovery was uneventful.

CASE 31. Reported by Outebridge. Female 34 years of age, had a large uterine myoma, with many adhesions in pelvis. There were numerous endothelium lined, numerous small grape like cysts filled with clear fluid. The omental margin, with a string of smaller ones running down the center. There was a continuous gradation from the simple dilated lymphatic channels to the largest cyst. The author believed that the per uterine adhesions blocked the lymphatic circulation and thus produced this lymphangiomatous dilatation.

CASE 32. Reported by Kenney and Mason. Female 30 years of age, had had abdominal discomfort for 6 years and swelling for 3 years. No pre operative diagnosis was made. A large multilocular cystic lymphangioma of the omentum was found. Some adhesions to the parietal peritoneum were present.

CASE 33. Reported by Bloodgood. Female, aged 3 years. This infant had had swelling of the abdomen for 3 months. An exploratory operation was done and a cyst in the lesser peritoneal cavity was opened and drained. The patient recovered and was well 1 year later.

CASE 34. Reported by Bloodgood. Male, aged 5 years. There had been intermittent attacks of abdominal pain for 18 months, with nausea and vomiting. Swelling of the abdomen, resembling ascites, was also present increasing rapidly during the last 6 weeks. Aspiration yielded 3 quarts of reddish fluid. At operation a large multilocular single cyst was found and removed. Twelve days later a second operation had to be done because the ligated omental stump had become gangrenous.

CASE 35. Reported by Bloodgood. A child, 4 years of age, had a large, single lymph cyst measuring 27 by 20 by 10 centimeters removed from the omentum. In its wall other minute cysts were found. The child was well 1 year later. No clinical data is given.

CASE 36. Reported by Pylkes. Female, 4 years of age. The abdomen was swollen since 9 months of age. It was tapped when she was 18 months, 3 years, and 4 years of age. Slightly red fluid, containing cholesterin crystals was obtained. Operation showed a thin walled cyst occupying larger part of abdomen. It was partially loculated and situated in the greater omentum, from which it was readily stripped. The upper part peeled from greater curvature of stomach. The omentum was repaired after removal, completing the anterior wall of the lesser sac. Recovery was satisfactory and the child was discharged in a week. The cyst was the size of a large soccer ball. Microscopic examination showed no epithelial lining to its wall.

CASE 37. Reported by Speese. Male, 5 years of age had a sudden abdominal pain 24 hours before admission. There had been no previous symptoms. The abdomen was found distended with some tenderness and rigidity over appendiceal region. The white blood count was 20,000 with 80 per cent polymorphonuclear cells. A diagnosis of acute appendicitis was made. At operation an omental cyst containing 35 cubic centimeters of amber fluid with pedicle twisted was found in the upper right abdominal quadrant. The cyst was removed. Death from anoxia occurred the next day. At autopsy numerous small clear cysts were found in the gastrosplenic and greater omentum. The cyst walls were lined with endothelium. Some of the omental lymphatics were dilated.

CASE 38. Reported by Halsted. Female, 2 years of age. The child had a swollen abdomen and the diagnosis of ascites was made. When a small incision for drainage of the abdomen was made, the delicate cyst wall presented itself and commenced to herniate. On further exploration a large thin walled hygrota and several smaller ones were discovered in the greater omentum and posterior mesogastrium. These were opened and drained. When the patient was seen at 24 years of age, she was normal, and there was no suggestion of an abdominal tumor.

CASE 39. Reported by Boncher. Male 43 years of age. Abdominal enlargement had been present since May, 1918, no other symptoms. Operation was advised when the patient was first seen in October, 1918, and refused. When brought back February, 1919, the child had an enormous abdomen hanging like a bag. He had to sit with legs wide apart to make room for belly. The abdominal circumference was 74 centimeters or 34 inches. Abdominal puncture yielded a small amount of brownish, albuminous liquid. The physical examination otherwise was negative, and the von Perquet test was negative. The diagnosis of ascites of unknown origin or "cystic tumor" was made. At operation a multilocular omental tumor was easily removed. Convalescence was uneventful and the child as well when seen 3 months later. The entire omentum was filled with cysts of all sizes, up to an infant head. These were supported by thick, fibrous, trabeculated septa, many intercommunications. They contained brownish shrunken albuminous fluid, which formed a sediment of fatty cells, lymphocytes, cholesterin crystals, and debris. The walls were made of dense, nuclear connective tissue, in which were many thin-walled dilated vessels. Some of the cavities were lined with endothelium. There were many lymphocytes in the supporting stroma and a loose network of smooth muscle fibers.

CASE 40. Reported by Gurvin. Female, 30 years of age. The patient was operated on for a uterine fibroid, which was found to be a twisted pedicle attached to and sur-

whed by the omentum. They found many lymphangiectatic cysts on the right side of the omentum and ascribed the cysts to blocking of the lymphatics.

CASE 41. Reported by Arsela. Female, 3 years of age. Gradual swelling of the abdomen began at 1 year of age. She was brought to the hospital for frequency of vomiting of 3 days duration. The abdomen was uniformly enlarged, smooth, fluctuant, and dull to percussion. The diagnosis of omental or mesenteric cysts was made. At operation a pedunculated cyst measuring 17 by 26 centimeters was discovered arising by a pedicle from the central region of the greater omentum. It was removed without difficulty and the child made an uneventful recovery. The tumor had a thin, transparent wall and contained clear lemon colored watery fluid. It was lined by flattened mesothelial cells. Many blood and lymph capillaries and clumps of lymphocytes were found in the wall, but no other cysts. The author attributed the cystic formation to an anomalous development of a lymph node.

CASE 42. Reported by Bernadet. Male, 24 years of age. The patient had had an abdominal tumor for 5 months, which suddenly became painful and caused vomiting. At operation a cyst the size of an apple, with twisted pedicle was found. The specimen was not described further.

CASE 43. Reported by Lawrence. Female, 3 years of age. The abdomen had been prominent since birth. There had been frequent attacks of abdominal pain for 6 months, relieved by cathartics 24 hours before admission to the hospital. She was taken ill with severe abdominal cramps. There was no vomiting and enemas gave no relief. When examined, she appeared prostrated, with a distended abdomen which was tense, smooth, dull to percussion, and cyanotic in color. There was a leucocytosis of 12,000 cells, with 82 per cent polymorphonuclears. At operation a large omental cyst with a twisted pedicle was found and removed. Convalescence was satisfactory. The cyst had several large communicating compartments, and was lined with endothelium.

CASE 44. Reported by Ladd. Female, 8 years of age. She had had for 3 months a distended abdomen which was flat to percussion and presented a fluid wave. Examination was otherwise negative except for undernutrition. Exploratory puncture yielded a brownish cloudy fluid containing broken down red cells. At operation a large thin walled cyst was removed from the great omentum, close to the transverse colon. This contained over 1,000 cubic centimeters of fluid. Microscopic examination showed the wall to be composed of alternate layers of smooth muscle and connective tissue. It was quite vascular and aggregations of lymphoid cells were seen about the blood vessels. The pathological diagnosis was omental cyst of lymphatic origin. Convalescence was uneventful.

CASE 45. Reported by Ladd. Female, 8 years of age. The patient had been losing weight for several months. When first seen, she complained of distended abdomen, headache, malaise and joint and muscle pain of 5 days duration. There had been no vomiting. Her white blood count was 10,500. There was found a large tumor mass on the right side of the abdomen which shifted to the hypogastric region. Cystoscopic examination was negative. At operation a large cyst measuring 13 by 8 by 6 centimeters was removed from the omentum. Its pedicle was twisted. Recovery was satisfactory. Microscopic examination showed a fibrous wall with a few strands of smooth muscle within it, and also some aggregations of lymphocytes. There was no epithelial lining. The pathological diagnosis was omental cyst of lymphatic origin.

CASE 46. Reported by Ryan. Male, 4 years of age. The abdomen had been large since birth, and was tapped at 2 years of age when a large amount of brown fluid was

removed. The swelling recurred again and respiratory embarrassment appeared. A smooth doughy mass was palpable in the upper mid-abdomen. Operation showed a multilocular cyst of the great omentum, forming a group of nine endothelium lined cysts with many small, round fibrotic masses in their walls. Convalescence was uneventful.

CASE 47. Reported by Rau. Male, 24 years of age. A tumor in the left hypochondrium the size of a marble was first noted 7 months earlier. This had grown rapidly to the size of an orange. Hematuria was also present for 3 months. The operation showed a cyst in folds of the great omentum which was easily peeled out. The tumor was 5 inches in diameter and contained white, milky fluid, its lining was thin and shiny. Recovery was uneventful. The blood disappeared permanently from urine 5 days after operation. No microscopic report was made.

CASE 48. Reported by Howe. Male infant aged 2 years. The patient had had a left inguinal hernia since 6 weeks of age. At age of 1½ years, this became irreducible and 3 weeks later was operated on. Before operation the tumor in the groin was the size of a small coconut, fluctuant and translucent. It could be partially reduced. The diagnosis of hydrocele was made. At hernial operation a large, single cyst with 30 ounces of clear dark yellow fluid was removed. This had one small diverticulum. No microscopic description was given.

CASE 49. Reported by Grausman and Jaffe. Male, 44 years of age. For several months, the patient had right lower abdominal pain with indefinite abdominal symptoms. On examination there was found diffuse abdominal tenderness, and a white cell count of 14,000 with 86 per cent of polymorphonuclear cells. At operation a large cystic omentum was found and removed. Hundreds of cysts varying from 1 millimeter to 1 centimeter in diameter were present. These were endothelium lined and contained clear fluid. The omental lymphatics were dilated and lymphoid cell infiltration with follicle formation had occurred. Recovery was uneventful.

CASE 50. Reported by Fisher. Male, 4 years of age. Abdominal pain and distress were present for 3 days. Examination revealed a large fluctuant abdomen with numerous dilated veins, a hard mass in the upper left quadrant with pain felt on pressure and reflected to the left inguinal region and causing marked flexure of both thighs. The white blood count was 13,050 with 75 per cent polymorphonuclears. Temperature was 100 degrees. At operation a large multilocular cyst and several smaller ones were found within the omentum. The entire omentum was removed. It weighed 13 pounds. Convalescence was uneventful, and there was no evidence of recurrence 1 year later. Microscopic examination showed the cysts to have a lining of flattened endothelium in addition many cavernous lymph spaces ramified through the omentum.

CASE 51. Reported by Wyzatt in *Minnesota Med.* 1931, 14: 656. Female, aged 3½ years. For 2 days child had had symptoms of acute appendicitis with fever, vomiting, abdominal pain and rigidity. At operation 1,000 cubic centimeters of green fluid was found in the abdomen. A large multilocular cyst in the great omentum measured 5 by 3 by 5 centimeters. One large chamber had ruptured. Microscopically the cysts had an endothelial lining.

SUMMARY

Two cases of lymphangiomas of the omentum are reported in detail and 51 were found in a careful survey of the literature up to date.

These tumors are true neoplasms and about two-thirds of them have occurred in children.

The symptoms produced by these tumors are due either to their size or to twisted pedicles.

They can be permanently removed by simple surgical treatment with little risk to the patient.

BIBLIOGRAPHY

- ARZELA, I. Contributo anatomico-patologico e clinico allo studio delle cisti lingatiche del grande epiploon Polichinco (Rome) *sezione chir* 1922, 13 4 7
- BERNARDI, G. Serous cyst of great omentum *Gynec et obst* 1925, 11 347
- BLOODGOOD, T. C. Letter included as part of article by Kenney and Mason
- BORSCHERS, E. *Beitr z klin Chir* 1920 113 7 1
- BOTD, Chin J 1903, 30 564
- BRADSHAW, Lancel, Lond 1898, 11 1478
- BRADOT, Omental Cystic *Zentralbl f Gynaek* 894, 18 901
- CADY, Bull Soc anat de Par 893, 68 312
- COSTA, *Gaz internaz d sc med Napoli* 1908 30 355
- COSTA, I. *Gaz internaz d sc* 1908, 30 357
- DEWITSKY and MOROSOW *Arch f Kinderh* 1905, 3 247
- ELZBOWSKA *New York J Gynec & Obst* 1893, p 614
- ERDMAN *Wien klin Rundschau*, 1896, 10 13
- FISHER, W. H. Lymphangioma of omentum *Ann Surg* 1928, 87 872
- FOOT *Ann Surg* 1907 4 3383
- FRANK, L. Omental cysts with report of a case *Am J Obst* 19 1 67 501
- FUNK *Surg Gynec & Obst* 19 4, 8 70
- GIACCHETTAIO *Gazz d osp* 1907 38 939
- GALDINGER *Tr Path Soc Lond* 851 52 374
- GIFFORD *Brit M J* 910, p 1280
- GIEVY and SPALSK *Ann Surg* 921 74 792
- GOODING *Lancet*, Lond 887 31
- GRAUTMAN, P. M. and JAFFE, H. L. Cystic lymphangioma of the greater omentum *Ann Surg* 1928, 87 66
- HAGSTED W. S. Self-evacuation of large abdominal hydrops *Bull Johns Hopkins Hosp* 920, 31 3
- HAKROUCK, E. M. Esomous endotheliomatous cyst of great omentum *Ann Surg* 903 48 206
- HEARN *Ann Surg* 1897 5 703
- HOLLSMAN *Zentralbl f Gynaek* 1906, 32 207
- HOWE, F. Omental cyst in inguinal hernia *Brit M J* 1928, 716
- JACOBI *Tr Am Am Phys* 1901 6 232
- KARSTEN *N M Lehre von den Geschwulsten des grossen Netzes Zentralbl f Chir* 1904, 35 247 (Original reference—Ruski Vrach, Moscow 4, 1907)
- KARL *Arch f path Anat etc Berl* 1907 128 138
- KIDNEY and MASON *J Nat M Ass* 1916, 8 87
- LADD, W. E. Two cases of omental cyst and one of mesenteric cyst *Am J Dis Child* 1926, 32 701
- LAWRENCE, C. B. A case of cyst of omentum with twisted pedicle *South M J*, 1935 18 423
- LICHT, F. Lymphango-endothelioma, case Atti d r Accad d fisicnat di Siena, 1928, 3 93
- LEWITSKY W. and MOROSOW A. *Seckbomij Lymphangiom des grossen Netzes Arch f Kinderheilk*, 1905, 42 247
- MARYAN *Presse med* 1896, p 133
- MARRON and McPHERSON *Am J Obst* 1913, 67 597
- Idem *Bull Lying-In Hosp New York* 1912, 8 70
- MARRON and MONTARRATT *Brit M J* 1904, 1 511
- MATTHEWS *Brit M J* 1905, 11 642
- OUTERBRIDGE *Ann Surg* 1914, 60 680
- PELTON, F. C. Omental cyst *Lancet*, Lond 1917 1 61
- RAO, B. S. Hematuria relieved after removal of cystic tumor of great omentum *India Med Gaz* 1926, 61 599
- RODMAN *Ann Surg* 1909, 49 427
- RYAN *Cysts of omentum Ann Surg* 920, 84 567
- SCHRAM *Zentralbl f Chir* 1903, 30 564
- SCHWARZEMBERGER *Beitr z klin Chir* 1894, 11 713
- SEITZ *Deutsche med. Wchnsch* 1909, 23 1790
- SEWEN *Bull Soc anat de Par* 1858, 33 30
- SPEER, T. Strangulation of omental cyst from twisted pedicle in a child *Internat Clin—youth series*, 1920, 2 246
- STILLMAN, S. Lymphangioma of the omentum and omental cysts *J Am M Ass* 1911 57 776
- VILLAR, J. d med de Bordeaux, 1908, 38 219
- WAXFIELD *Surg Gynec & Obst* 1907 5 227
- LOURE *Lancet*, Lond 1905, 1 157

BRANCHIAL CARCINOMA

LATERAL CERVICAL NEOPLASM

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THE fact that less than 100 cases of branchiogenic carcinoma have been reported in the literature, and that the largest single series that we have been able to discover is that reported by Lorenz, who reports but 8 cases, makes it appear that it would be of interest to present our observations in a series of 28 cases seen by one of us at Lakeside Hospital and at the Cleveland Clinic. Although branchial carcinoma is among the most malignant lesions and the disease is usually fatal nevertheless, it is well to accumulate experience in the treatment of the lesion in order to find what therapeutic methods offer the best chance of relief or of temporary cure.

Branchial carcinoma was probably first described by von Volkman, in 1882 as a tumor of the neck for which no source could be found in the skin lymph glands, nose mouth pharynx ears or esophagus. (Essentially the same factors are present in the diagnosis today.) Hudson presented a series of 6 cases of so called branchial carcinoma in which 5 came to autopsy and revealed other sources to account for the lesion. However in view of all the evidence available today such a pathological entity surely exists although its exact mode of origin is obscure.

CLINICAL PICTURE

The total number of cases of branchial carcinoma in our series is 28 all of which were studied pathologically and were definitely diagnosed. Autopsy in 1 case disclosed no other site of malignant change. For comparison with the data on malignant branchial lesions 70 cases of benign cysts have also been studied and presented in a few of the tables. Our results closely approximate those of Shedden.

The age of occurrence of lateral cervical carcinoma, as is the case with most carcinomatous lesions falls in the latter decades of life. Two-thirds of the patients in this series had attained the age of 50 years while nine-tenths were more than 40 years of age. The oldest patient was aged 80 years and the youngest was a man aged 37 years. Comparisons between the ages of occurrence of benign and malignant lesions in our series are shown in Table I and Figure 1.

Branchiogenic carcinoma seems to occur more frequently in men than in women but no relation

ship between incidence and the occupation of the patient could be demonstrated. There is approximately an equal distribution of lesions between the two sides of the neck, but bilateral occurrence was noted once in our series. The growth of the malignant tumors is rather rapid as compared with those of a benign nature. In the case of the malignant tumors, the longest period before the patient appeared for treatment was 3 years with an average of about 7 months while in the case of the cystic lesions the longest period before the patient presented himself for treatment was over 4 years. Nine tenths of the patients with branchial carcinoma reported the speed of the growth as rapid, while only one third of those with cysts showed rapid increase in size which is seen chiefly in the younger patients (Tables II and III).

The site of branchial carcinoma is usually high in the neck below the angle of the jaw or in close proximity to the ear near the sternocleidomastoid muscle (Fig 2). Only one patient in this group had a lesion close to the clavicle (Fig 3). The occurrence of pain is fairly frequent and this is referred to the side of the face back of the head, shoulder, base of the tongue, and down the arm on the affected side. In the early stages the pain usually is intermittent, but, because of the close proximity of the growth to the nerves and their early involvement, the pain soon becomes quite severe and continuous. In some cases there was a specific involvement of the seventh, eighth, and ninth nerves and in 1 case a definite Horner's syndrome was present, due, of course to the involvement of the cervical sympathetic system. Three-fourths of the patients with carcinoma complained of pain while only one tenth of the patients with cystic lesions had this symptom (Table IV).

Malignant branchial tumors do not have a constant size, but usually average about 3 to 4 centimeters in diameter and are very firm in consistency unless degeneration has occurred, or a cyst is also present. Usually the tumor is not fixed to the skin unless some manipulation has preceded the examination, but it is very firmly attached to the underlying structures. In the differential diagnosis it is of interest to know that the cystic lesions are seldom attached to the underlying

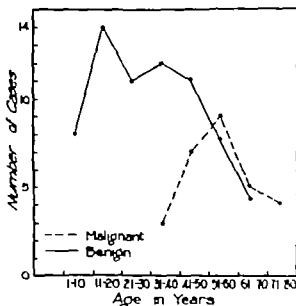


Fig. 1 Comparison of age incidence of benign and malignant branchial tumors in our series of cases.

structures, and never to the skin unless they have become secondarily infected and break through.

When patients with branchial carcinoma are first seen, they usually are enjoying fairly good health. About 25 per cent showed some weight loss, and 30 per cent had a definite anemia. The previous health is seemingly irrelevant as most patients do not even report any previous upper respiratory infection, and in only 1 case could the presence of tuberculosis be demonstrated in the pathological tissue removed. A positive Wassermann reaction was found in 1 case.

Of the patients in the series who had an ear, nose, and throat examination, in only 2 was it felt that lesions which might possibly account for



Fig. 2 Lateral branchial tumor in a patient 58 years of age; duration of tumor growth 2 months. This is a typical location and shows the very rapid growth that may occur.

the tumor as a metastatic growth were demonstrable. In 1 of these cases it was thought that there was a carcinoma of the larynx, but at necropsy the growth proved to be a direct extension of the branchial carcinoma in the pyriform sinus. In the other case there was a demonstrable mass in the posterior nasopharynx, but on removal of the tumor in the neck a typical pathological lesion could be seen in a cyst wall.

In 11 of the cases in our series roentgenograms of the chest were made and in 3 definite metastases were evident. In 2 cases there were palpable inguinal and axillary lymph nodes. Roentgen examination of the skull jaw and craphagus in several cases demonstrated no pathological change.

The family history is of no importance as only one patient in the group reported the occurrence of cancer in the family.

DIAGNOSIS

In making the differential diagnosis, all tumors of the neck, including mixed tumors, must be considered. Among the more common of these conditions is tuberculosis of the cervical glands, especially when some degenerative process is present. Usually tuberculosis occurs earlier in life than does branchial carcinoma, and there are many nodules rather than a solitary tumor. Leucemia and Hodgkin's disease may be differentiated by blood counts. The diagnosis of a lipoma when it lies above the fascia is readily made, but when the tumor lies deep, the diagnosis is quite difficult and often the nature of the growth can not be determined until the neck is incised.

TABLE 1—AGE INCIDENCE OF BRANCHIAL LESIONS

Age in years	Benign		Malignant	
	Cases	Per cent	Cases	Per cent
or under	8	25		
31-40	5	25		25
51-60		19	14	30
Over 70				5
Unaggreg.	Newborns		27 cases	
A group	89 cases		25 cases	
Older	66 cases		20 years	

Metastatic lesions may occur in the jugulodigastric glands from the ear nose or throat, and it should be borne in mind that in chronic retropharyngeal abscess these glands become quite firm hard and tender and lymphosarcoma also must be ruled out.

Thyroglossal cysts and adenomata of the thyroid gland must be differentiated, but these usually lie in the midline. A few of the rarer lesions such as aneurism deep seated hemangioma, cystic hygroma, and solitary lymph cyst must be considered but most of these conditions must be treated surgically so a definite diagnosis is not essential before operation. It should be remembered that aspiration of a branchial cyst yields a typical fluid.

TREATMENT

The only available methods of treatment of branchial carcinoma are radiation with radium or the X ray or both, and radical removal.

Dr U V Portmann feels that radium can not be used in adequate doses without causing a sloughing of the great vessels which are in such intimate relation with the tumor. The tumor is resistant to roentgen therapy but this is administered to help relieve the pain. Portmann makes an attempt to keep the tissues saturated with the radiation for a considerable period of time. Short wave lengths should be used and a full erythema dose administered for one course of treatment which may be repeated once if necessary. Since branchial carcinoma is highly resistant to radiation roentgen treatment is purely palliative.

The method of treatment employed in most of our cases has been a combination of surgery and X ray. The pre-operative care of the patient is of little consequence except for the possibility of radiation before the procedure and in cases of profound anemia the use of blood transfusion especially in elderly patients. Nitrous oxide anesthesia should be employed. Local anesthesia should be avoided as there is the possibility that infiltration into the area may spread the malignant cells.

OPERATION

In the removal of branchial carcinoma the incision should be made over the tumor parallel to the ramus of the jaw the middle of the incision being over the tumor. At this point when necessary a cut may be made parallel to the sternocleidomastoid muscle which should be long enough to give an adequate exposure. In most cases the skin may be saved in its entirety, for usually the neoplasm has not extended to it, but in a few cases in which previous treatment has



Fig. 3 Lateral branchial tumor in a patient 48 years of age. duration of tumor growth approximately 18 months. This photograph is included to show our one case in which the location of the lesion was atypical. The incisions which are present were made before the patient was seen here.

caused the tumor to spread to the skin, it must be sacrificed. As is true of dissection of cancer anywhere in the body, the preservation of anatomical structures should not be considered. It is most important that the dissection be made with a sharp knife thus avoiding all traction or pulling of the tissues.

The muscular structures which should be removed are the sternocleidomastoid thyrohyoid and other infrahyoid muscles, the rectus capitis anticus major digastricus and at times the anterior scalenus muscle.

The lymphatics are of little import and should be completely removed. There is little evidence

TABLE II.—DURATION* OF BRANCHIAL LESIONS

	Cysts	Carcinoma
Shortest period	8 weeks	10 days
Average period	4 years, 6 months	7 months, 2 weeks
Longest period	34 years	5 years

*Period before patients presented themselves for treatment.

TABLE III.—COMPARISON OF RATE OF GROWTH OF BENIGN AND MALIGNANT BRANCHIAL LESIONS

	Benign		Malignant	
	Cases	Per cent	Cases	Per cent
Slow			2	7
Rapid	3	27	25	90
Alternating increase and decrease in size				3

of the occurrence of lymphoedema after the re-

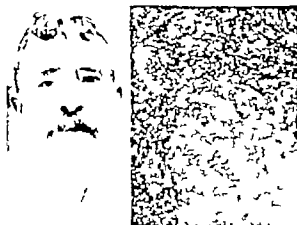


Fig. 4. Branchial tumor on the right side of the neck, duration of tumor growth 3 months. Left, photograph of patient, 50 years of age. Right, section of tumor showing not only malignant change but a few scattered giant cells suggesting an old tuberculous infection.

removal of the lymphatic chains from both sides of the neck. The only vein of any consequence which is involved in the dissection is the deep or internal jugular. This vein has been tied and resected in so many instances that it need only be mentioned.

The important artery to be considered is the common carotid. When this is resected, anastomoses are made through the vertebrals inferior and superior thyroids, and the deep cervical arteries supplying the circle of Willis. The literature shows that the mortality rate following ligation of this blood vessel is 12.5 per cent and that about 25 per cent of the patients show some subsequent mental change. The proportion of deaths and psychoses among older patients after liga-

tion of the common carotid is even higher and since most patients with this disease are beyond middle life, every effort should be made in order to save this vessel.

OPERATIVE RESULTS

The most common immediate operative result is a collection in the wound of a large amount of serum which is troublesome because it tends to push the skin away from what is left of the underlying structures. This can be prevented by the application of large pressure dressings over this area. We use skin clips with a few black silk stays and have found that this is a very satisfactory method of closure.

Of course, as in all elderly patients, the immediate danger is that of pneumonia, and this caused 2 of the 4 postoperative deaths in our series. Of the 2 others, 1 died from shock, and the other following a laryngectomy.

In 1 of the patients in this series a postoperative psychosis developed but there was a history of some senile change before the operation, and at the time of writing this patient is still living 3 months after operation but has shown very little mental improvement.

There usually is no difficulty in the muscular movement of the head after the immediate trauma and stiffness have subsided.

The damage to the sympathetic system is evident immediately and no improvement in this respect is ever noted. The pupil on the side operated upon is contracted and ptosis of the lid develops, caused by a paralysis of Mueller's muscle resulting from the cutting of the superior cervical ganglion. When the vagus nerve is cut,



Fig. 5. Photomicrographs of sections of a branchial tumor removed from a patient 5 years of age, duration of tumor growth 6 weeks. Left, photomicrograph, $\times 100$. Right, photomicrograph showing the definite cystic nature of the lesion, $\times 200$.

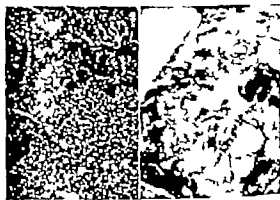


Fig. 6. Photomicrographs of sections of a branchial tumor removed from a patient 50 years of age, duration of tumor growth 12 months. Left, photomicrograph, $\times 200$. Right, photomicrograph showing a larger area with a cyst wall in the lower portion, $\times 200$.

an immediate change in the rate of respiration is noted and also a rapid increase in the pulse rate. The vagus nerve on the right side of the neck is supposed to have less influence on the heart and gastro-intestinal tract than does the vagus nerve on the left, although, in our experience, the cutting of this nerve on either side produced little or no permanent effect. Most of the respiratory and cardiac changes disappear within 24 hours.

Paralysis of the vocal cords is permanent, of course, and the patient always has some huskiness of the voice. The phrenic nerve lies beyond the structures involved and is usually avoided at operation, but, if it were cut, there might be a collapse of the lung on that side.

END-RESULTS

In this series of cases, 11 patients were treated by surgery alone. Two died from postoperative bronchopneumonia. Five left the hospital, 4 of them in good condition on discharge, but the fifth was unable to swallow on account of paralysis of the glossopharyngeal nerve. Two of the 4 remaining patients died respectively, 9 and 10 months after operation. Two are still living: 1 in very poor condition at the end of 1 month, and the other is alive at the end of 3 months with a postoperative psychosis.

Six patients were treated by surgery and postoperative deep roentgen radiation. One of these died following a laryngectomy which was performed because of the extension of the tumor into the pyriform sinus. Two others have died, 1 at the end of 3 months after operation after only one course of roentgen radiation; the other at the end of 11 months after operation following three courses of radiation over the entire side of the neck and head. Two are living at the end of 2 months after operation but 1 of these patients is in very poor condition because of metastasis to the lung and the other patient in this group is in very poor condition 4 months after operation.

One patient, who was treated with one course of radiation preceding operation, and postoperative radiation with roentgen rays and 2,080 milligram hours of radium, died 12 months after operation.

Another group of 5 patients was treated only with roentgen radiation distributed over the head and neck. These all received at least 1 complete course averaging about 60 per cent of an erythema dose at each treatment. Two of these patients died within 3 months, and a third lived 7 months. The fourth patient is in poor condition at the end

of 1 month after treatment. The fifth patient is living 4 months after the first treatment and 8 months after the lesion was first noted, and is apparently in good health.

One patient was treated with radium alone, receiving 2,340 milligram hours at the first treatment and 2,600 milligram hours 2 months later and died 6 months after the first treatment.

Four patients were treated with both roentgen and radium radiation and all died within a period of 9 months after the first treatment. The patient who received the smallest dose of X ray and radium lived the shortest length of time after the treatment, and the one who received the largest amount both of X ray and radium had the next shortest survival period, the patient who received the next to the smallest dose lived the longest (9 months).

In 8 cases not included in this series, there was a clinical diagnosis of a branchial tumor but no pathological examination. These patients received no treatment and their average duration of life after their first examination was approximately 6 months.

These data show that the results of treatment of branchial carcinoma are not good, no matter what the treatment, but in view of the fact that Roeder has reported that 1 patient treated by radical operation and roentgen radiation has survived for more than 4½ years, we feel that every patient should be subjected to these therapeutic procedures with the hope that perhaps a few may be definitely benefited.

PATHOLOGY

The pathological picture presented by these cases of branchial carcinoma is that characteristic of squamous cell carcinoma. Grossly, if the origin of the tumor is a cyst, there is usually some evidence of the cyst wall and often a definite capsule infiltrated by the tumor can be demonstrated. The blood supply usually is scanty and gives rise to the frequent areas of necrosis, as well as the hyaline degeneration. Often a flaky yellow semisolid content typical of that seen in a simple cyst is noted, and the neoplastic change may involve only a portion of the cyst lining.

Microscopically there is a fibrous tissue stroma with the tumor cells arranged in whorls of branching cords with no evidence of connective tissue between the cells. In addition, there may be noted nests containing cells more densely packed together, showing typical pearl formation. The cells themselves are polyhedral in shape and irregular in size, with the nuclei taking varying amounts of stain. A frequently noted fact which

TABLE IV —INCIDENCE OF PAIN WITH BRANCHIAL LESIONS

	Cysts		Carcinoma	
	Cases	Per cent	Cases	Per cent
Present	11	8	17	61
Absent	25	96	6	21
Not mentioned	16	96	5	18

is significant of rapid growth is the remarkably large number of mitotic figures, with many of them asymmetrical and bipolar. This growth, together with the poor blood supply leads not only to gross areas of necrosis, but to numerous isolated degenerating cells and cell groups showing karyolysis and isolated groups of nuclear granules (Figs 4, 5 and 6)

PATHOGENESIS

Branchial or branchiogenic carcinomata arise from embryonic rests which for some unknown reason are stimulated into growth. As would be expected therefore, they frequently are associated with branchial cysts, and therefore a study of the embryological etiology of branchial cysts may throw some light upon the pathogenesis of branchial carcinoma.

A brief review of the literature regarding the embryological etiology of branchial cysts shows that there are numerous hypotheses, each and every one of which seems to explain, at least in part, the presence of such abnormalities. The histological elements in these cysts, namely connective, lymphoid, and epithelial tissue, are evident in the embryonic structures in all theories presented. It may be true that each has its individual application and that, when branchial carcinomata are studied, all these hypotheses must at least be considered as factors. The evidence at the present time seems to point toward Wenglowski's theory as the most acceptable.

In 1912 Wenglowski published one of the most important single contributions on the etiology of cervical cysts and fistulae. This has been translated by Meyer. His papers are the result of intensive work over a period of 5 years. He concluded that sufficient evidence is shown to prove that branchiogenic rests may be limited above by the jaw and below by the hyoid bone—that cysts and sinuses found outside this area along the mesial border of the sternocleidomastoid muscle and above the suprasternal notch are anomalies occurring in the so called "thymacopharyngeal duct."

Christopher greeted this theory very favorably and felt that it completely abolished the branchiogenic theory regarding the origin of branchial carcinoma. Shedden was hesitant and presented a table of Wenglowski's conclusions as criticized by Kingsley which substantiated his doubts concerning the ability of this hypothesis to explain all the abnormalities in this area.

Frazer (5) suggested that these abnormalities may be the result of "placodal cysts or ducts, or of the ectodermal external pharyngeal ducts which are connected with the entodermal pouches, and this author has also shown the embryological relationship between the branchial cysts and the hypoglossal nerve. Hyndman and Light suggested essentially the same idea.

Not to be forgotten are the important early contributions to this subject by Rathke, Bland-Sutton and Cusack. The last 2 authors concluded that if any abnormality in growth should cause the arches to obliterate the grooves, a fistula or cyst might result and that these pathological conditions might occur at levels corresponding to the various unobliterated clefts. Another interesting hypothesis was advanced by Rahl who felt that these anomalies arise from an improper obliteration of the cervical sinuses.

SUMMARY

1. Branchial carcinoma is a distinct pathological entity. It is comparatively rare less than 100 cases have been reported in the literature.

2. Branchial carcinomata arise from embryonic rests which for some unknown reason are stimulated into growth.

3. Because of the rarity of this lesion and its high degree of malignancy which demands every resource for palliation and prolongation of life, a series of 28 cases, diagnosed pathologically as branchial carcinoma, is reviewed with special reference to treatment.

4. The clinical picture is described and the conditions to be considered in the differential diagnosis are listed.

5. The method of treatment by surgery and by radiation is described, and the immediate and remote results are recorded.

6. Only palliative results and the prolongation of life can be expected from any treatment, as the disease is usually rapidly fatal. From available evidence it seems probable that radical excision followed by radiation offers the best chance of relief to the patient with branchiogenic carcinoma.

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REFERENCES

- 1 BLAND-SUTTON J On branchial fistulae cysts, diver-
ticula and supernumerary auricles *J Anat. &
Physiol* 1887 21 289-298
- 2 CHRISTOPHER F Surgical treatment of lateral cervi-
cal fistulae. *Surg Gynec & Obst* 1924, 38 329-
335
- 3 CUBERT J Étude sur l'appareil branchial des verté-
brés Thèse de doct, Paris, 1877 No. 174
- 4 FRAXER J E Nomenclature of diseased states caused
by certain vestigial structures in the neck *Brit J
Surg*, 1923 11 131-135
- 5 Idem Disappearance of precervical sinus *J Anat*
1926 61 132-143
- 6 HUNSON R V So called branchiogenetic carcinoma
its occupational incidence and origin *Brit J Surg*
1929, 14 280-294
- 7 HANDMAN O R, and LIGHT G Branchial apparatus
its embryologic origin and pathological changes to
which it gives rise, with the presentation of fam-
ilial group of fistulas *Arch. Surg* 1929, 19 410-
452
- 8 LORENZ, H. E. Das branchiogene Carcinom Beitr z.
klin. Chir 1913, 85 599-632.
- 9 MEYER, H. W. Congenital cysts and fistulae of the
neck. *Ann. Surg*, 1932 95 1-26 226-248
- 10 PORTMAN U V Personal communication
- 11 RABL, H. Ueber die Anlage der ultimobranchialen
Körper bei den Voögeln *Arch f mikr Anat*
1907 70 130-173.
- 12 RATHKE. Cited by Meyer op cit
- 13 RORDER, C A. Malignant degeneration of a branchial
cleft remnant *J Am M Ass* 1929, 93 103-106
- 14 SHEDDEN W M Branchial cysts and fistulae New
England J Med 1931 205 800-811
- 15 VON VOLKMAN Cited by Ewing, James Neoplastic
Disease 3d ed. p 1023 Philadelphia W B
Saunders Co 1928.
- 16 WYKOŁOWSKI Cited by Meyer op cit

RUPTURE OF THE KIDNEY PELVIS

REVIEW OF THE LITERATURE¹

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RUPTURE of the kidney pelvis is a relatively rare lesion of the kidney. The author has collected 61 cases of rupture of the kidney pelvis from the literature and has added 3 personal cases. In this series of 64 cases, there are 31 cases of traumatic rupture, 26 of the spontaneous type, 3 following instrumentation of the ureter and 4 following pyelography. These cases are grouped under their respective headings in the bibliography. It is possible and indeed very probable, that many more similar cases have been encountered but have not been reported or are reported in connection with some other renal lesion, i.e. ruptured hydronephrosis, renocolic fistula, etc. and hence are not readily discernible in the rapidly increasing urological literature.

In this series, the author has collected only those cases in which the rupture is strictly confined to the pelvis of the kidney and has excluded those cases (a) in which the rupture has occurred at a terminal calyx (Fritz, 2 cases; Henline) (b) in which an associated rupture or tear occurred in the renal parenchyma and (c) in which a perirenal, psoas or vertebral abscess opened into the renal pelvis.

True rupture of the kidney pelvis may be conveniently classified into the following two types: traumatic and non-traumatic or spontaneous. The traumatic type of ruptured pelvis, unassociated with a parenchymal injury is more frequently encountered than the spontaneous type and is usually observed in those cases of ruptured hydronephrosis in which the external force is sufficient to produce an uncomplicated rupture of the thin pelvic walls found in pyelectasis. The spontaneous type of ruptured pelvis usually occurs in those patients who have associated pathology in the upper urinary tract, i.e. pyelitis or hydronephrosis secondary to an inflammatory lesion or congenital or acquired obstruction (stone stricture, etc.) of the ureter or pelvis.

ETIOLOGY

There are various extrinsic and intrinsic factors or conditions which may serve as predisposing or etiological agents in the production of a rupture or perforation of the renal pelvis. The most common extrinsic factor is trauma of a direct or indirect nature. The most important intrinsic

factors are (1) infections of the renal pelvis, (2) stone or stricture in the pelvis or ureter, (3) hydronephrosis, (4) operative defects, (5) instrumentation, i.e. ureteral catheterization and (6) syringe pressure pyelography. While some of these conditions bear a greater etiological significance than others, a brief consideration of each is presented.

Trauma. The etiological relationship of trauma to rupture of the kidney parenchyma has been repeatedly emphasized by many writers. A review of the important contributions to this subject is in order since the external forces concerned in the production of a rupture of the kidney pelvis are essentially the same as those responsible for a rupture of the kidney parenchyma. Rayer and Tuffier were the first to emphasize the fact that an injury to the kidney may be caused by the jarring from a direct blow on the body. LeDentu explained kidney injuries on the same basis as a brain injury due to a blow on the opposite side (*contre coup*). Schede pointed out the possibility of throwing a distended kidney against the transverse process of a vertebra while Morris attributed a similar rôle to the floating ribs. Kruster has stressed the effect of hydraulic pressure acting through full blood vessels and a distended pelvis and causing the organ to burst along lines which radiate for the most part from the pelvis and tubules toward the point of maximum impact of the lower ribs, the opposing resistance being supplied by the vertebral column. Guterbock has suggested the possibility of a force so exerted that the poles of the kidneys are squeezed together producing transverse fissures and conceivable ruptures. Keen maintained that the line of cleavage follows the direction of the uriniferous tubules. Grawitz explained the tendency to radial fissuring on the basis of the fetal arrangements of the kidney but this theory lacks histological proof.

The most frequent modes of injury to the kidney parenchyma or pelvis are (1) the application of direct force against the kidney, i.e., a fall, blow or compression which drives the kidney against the lower ribs or against the transverse processes or bodies of the lumbar vertebra, (2) the application of indirect force producing a concussion such as may occur following (a) jarring the body as in landing on the feet after a fall, (b) undue muscular

effort as in sneezing, coughing, straining, lifting heavy objects, etc., (c) acute flexion or other sudden movements of the body, (3) penetrating forces such as a gunshot injury, stabbing, etc. The latter type is more likely to result in an injury to the parenchyma or vascular pedicle than to the pelvis.

At times it appears to be well nigh impossible to explain the occurrence of a rupture of the kidney parenchyma or pelvis following what appears to be a slight injury or inadequate force. The extent of the damage to the renal parenchyma or pelvis may be out of proportion to the degree or amount of the force. The direction of the force and the pathological and physiological condition of the kidney parenchyma and pelvis often determine the type of injury to these structures. It is the general impression that an infection or distention of the kidney parenchyma or pelvis greatly increases the susceptibility of that organ to rupture by external violence. This is borne out by the increasing number of reports of rupture of hydronephrotic kidneys in the recent literature. In many cases of traumatic rupture of the kidney, the laceration or tear in the kidney parenchyma is very often accompanied by a coincidental tear in the renal pelvis or the parenchymal rupture extends directly into the pelvis but in such cases the pelvic rupture is always overshadowed by and secondary in importance to the parenchymal injury.

Infection The etiological significance of an acute or chronic infection of the pelvic walls in production of a traumatic or spontaneous rupture of the pelvis has not been clearly established. The presence of such an infection, unaccompanied by a pelvic or ureteral obstruction, apparently has but little causative significance in cases of ruptured pelvis due to external violence other than producing a potential weakness of the pelvic walls which increases the susceptibility of the tissues to any type of injury. Undoubtedly a pelvic infection plays a more important rôle in etiology of the spontaneous type of rupture. This contention is based on the fact that a rupture of the pelvis is more likely to occur in those cases where the pelvic walls have been weakened by an acute or chronic inflammatory process and are subjected to the influence of other factors such as an increased intrapelvic pressure or irritation from an impacted irregular stone. It can be readily understood how an ulcer with a thin base and inflamed margins may serve as a potential site for a perforation or rupture under similar conditions. Two cases of ruptured pelvis secondary to a chronic pyelonephritis were reported by Fritz and Mathe. In

10 cases the rupture occurred in a pyonephrotic kidney secondary to a calculus or stricture in the ureter or pelvis.

Stone or stricture in the upper urinary tract The presence of a stone in the ureter or pelvis may influence, directly or indirectly, the development of a traumatic or spontaneous rupture of the pelvis. The pathological sequelae of stone in the upper urinary tract, i.e. obstruction, retention, infection, and ulceration are well recognized. Thus a ureteral or pelvic stone may be indirectly responsible for the rupture of the pelvis by virtue of the fact that these accompanying secondary changes in the pelvic walls increase the susceptibility of this structure to rupture following a mild or severe traumatic insult. If an infection supervenes, the thinned pelvic walls resulting from pyelectasis are further weakened so that any extrinsic or intrinsic pressure may produce a rupture of the pelvis. In the analysis of the reported cases it was found that a stone was present at the ureteropelvic junction in 3 cases, in the ureter in 9 cases, in the pelvis or calyces in 14 cases.

A stone in the upper urinary tract may be the direct cause of a pelvic rupture. When the calculus is small, smooth and movable, the irritation and ulceration of the mucous membrane is insignificant. If the stone is large with irregular jagged surfaces and in a more or less fixed position, the ulcerating process may be more extensive and produce a localized area of necrosis which serves as an admirable site for spontaneous perforation. Should the stone be encysted or impacted, the ulceration progresses rapidly and deeply involving all the layers of the pelvic wall, and soon results in a perforation with the escape of the pelvic contents i.e., infected urine and occasionally the stone, into the peripelvic and perirenal tissues.

Any intrinsic or extrinsic obstruction of the ureter may be indirectly responsible for a rupture of the pelvis by virtue of subsequent development of a hydronephrosis or pyonephrosis. In the case reported by Schmidt, the pelvic rupture occurred in a hydronephrotic kidney secondary to an aberrant vessel crossing the ureteropelvic junction. In one of the author's cases, a stricture at the ureteropelvic junction was the probable etiological factor responsible for the pelvic rupture.

Hydronephrosis In 1909 Legueu distinguished three types of hydronephrosis associated with trauma, viz (1) true traumatic hydronephrosis—this type has all the physical characteristics of an ordinary hydronephrosis but owes its origin to some traumatism. The dilatation of the kidney pelvis occurs at the expense of the kidney paren-

chyma and is the result of a more or less complete obstruction of the ureter or pelvis by either a blood clot or a faulty reparative process in the injured kidney pelvis or ureter (2) pseudotraumatic hydronephrosis—this type is the result of an injury to the kidney pelvis or ureter which is followed by an extravasation of urine and occasionally blood, into the surrounding tissues, and by the development of a well defined sac about the extravasate. This condition is sometimes called pseudohydronephrosis and is seen most frequently in young individuals and (3) ruptured hydronephrosis—in this type a rupture of a pre-existing congenital or acquired hydronephrotic kidney occurs as the result of direct or indirect trauma.

It is the latter type (group 3) which is of particular interest from the standpoint of rupture of the kidney pelvis, for by far the greatest percentage of cases of ruptured pelvis are cases of ruptured hydronephrosis. The author has reviewed 72 cases of ruptured hydronephrosis of both the traumatic and spontaneous forms and found that in 17 cases the rupture or tear was in the mucous membrane of the pelvis. An analysis of this series of 72 cases reveals the fact that ruptured hydronephrosis is most frequently associated with direct trauma although indirect trauma and muscular action is the responsible factor in a few cases.

A very slight injury may be the cause of rupture of a hydronephrotic kidney especially in children and adolescents as occurred in Lazarus a patient who developed a tear in the renal pelvis following a glancing blow received during a basketball game. In Schmidt's case, the rupture occurred while the patient was rowing. Herman states that in about 50 per cent of the cases of ruptured hydronephrosis, the renal injury followed what appeared to be insignificant trauma or was of such mild intensity and degree that it is safe to assume that similar injury would not cause more than a superficial bruise in a normal individual.

It is interesting to note that several cases of spontaneous rupture of a hydronephrosis have been reported. In many of these so called spontaneous ruptures, it is possible and very probable that either or both the patient and the physician have overlooked some mild form of trauma. However there are several cases of spontaneous ruptured hydronephrosis in which a traumatic factor can be eliminated but careful examination in these cases practically always reveals some secondary etiological factor i.e. pyelitis or stone.

While it is true that mild trauma or muscular action may produce a ruptured hydronephrosis in children it is difficult to conceive how these same agents can produce the same effects in adults with hydronephrosis. It has been the experience of every urologist to frequently encounter men with very large hydronephroses who are employed at very arduous mechanical trades or at heavy manual labor requiring unusual muscular effort and considerable use of intra-abdominal pressure and who continue to work at their trades for many years without damage to their diseased kidneys. A possible explanation for the greater incidence of ruptured hydronephrosis and incidentally ruptured pelvis in children and young adults is the fact that the kidney is situated at a lower level in children as a result of the persistence of the infantile type of psoas as pointed out by Aglave. Other predisposing factors in children are the lack of protection of the lower ribs as suggested by Gibson and the diminished amount of perinephritic fat and increased tension of the posterior parietal peritoneum in the region of the kidney as maintained by Harrigan. The abdominal musculature is better developed in adults and can help ward off or minimize the effects of traumatic forces directed against the kidney.

Rupture of the pelvis following plastic operation. Spontaneous rupture or perforation may occur several weeks or months after a plastic operation on the renal pelvis. The occurrence of a rupture or perforation following a plastic operation on the pelvis may be attributed to a faulty operation and is due to either a recurrence of the old obstruction or to the production of a new obstruction. In either instance there results an increased back pressure which is exerted on the potentially weakened portion of the pelvis namely the suture line. These untoward results were frequently encountered in the early days of conservative plastic operations on the renal pelvis and were responsible for the slow recognition accorded this deserving operative procedure. However when the proper precautions are taken at the time of operation to insure and institute good drainage by inserting a nephrostomy tube splitting the ureter etc., accurate healing occurs and unpleasant accidents are avoided.

Walters recently emphasized the postoperative complications which are likely to occur following plastic operations on the renal pelvis for hydronephrosis. He stressed (1) the leakage of urine at the point of anastomosis with perineal extravasation (2) retention of the urine in the kidney leading to pyelonephritis or cortical

abscesses and (3) ureteral obstruction at or below the pelvic incision with a persisting urinary fistula from the site of pelvic anastomosis. Three of the 8 cases, in which resection of the pelvis was done, later required a secondary nephrectomy due to persistent urinary fistula as a result of occlusion of the ureter by postoperative infection around the ureter (1 case) and pyelonephritis and cortical abscesses (2 cases).

Rupture of the pelvis following instrumentation of the ureter. Perforation of the renal pelvis by a ureteral catheter has been known to occur in rare instances. Hunner reviewed a series of over 20,000 cystoscopic treatments of the ureter by the Kelly method and reported 21 accidents which included 12 personal cases and 9 cases occurring in the practice of his associates. An incidence of one accident in each thousand ureteral catheterizations indicates a very low morbidity. Nevertheless it serves to emphasize the fact that this procedure may be attended by an unpleasant complication in hands of inexperienced cystoscopists. In this series of 21 cases there were 4 cases in which the perforation occurred in the pelvis or in the upper third of the ureter near the ureteropelvic junction.

Wesson states that the wall of a normal ureter cannot be punctured by the ordinary ureteral catheter and maintains that it is doubtful if a diseased ureter can be perforated unless a deep ulcer is present. He pointed out that when the ordinary catheter is passed through the cystoscope and the tip of the catheter meets with the resistance of the urethral wall, the catheter will buckle. Similar results were obtained when a maximum pressure was exerted in passing a catheter up the ureter through the bladder of freshly obtained autopsy specimens. He is of the opinion that perforation can occur if a wire stylet is used or the catheter is equipped with a whalebone tip such as is used in the Kelly method of direct cystoscopy. In this connection, it is well to point out the danger of perforating the ureter when any one of the various metallic ureteral stone extractors is used. Wesson also showed that it is impossible to perforate the kidney capsule with an ordinary ureteral catheter.

Rupture of the pelvis as a complication of syringe pressure pyelography. One cannot stress too strongly the danger of producing a rupture of the pelvis in employing the syringe method of pyelography. Any pelvis or ureter whose walls have been weakened by the presence of a stone, chronic infection, abscess formation, tumor, etc., is a potential site for a rupture when too much pressure is exerted in injecting the pyelographic

medium as has been pointed out by Hoffman, Hunner, Mathe, Hartman, Wesson and Kindall. The syringe method of injecting the pyelographic fluid without manometric control should not be used in the diagnosis of those cases in which an impacted ureteral or pelvic calculus, chronic infection, abscess formation or tumor of the pelvis is suspected. The low pressure gravity is a safer procedure and practically devoid of the danger of perforation. In his discussion of Kindall's paper, Hunner stated that spontaneous rupture may follow even the gravity method if stricture or some other form of obstruction causes prolonged trapping of the fluid. Hoffman has reported 3 cases of perirenal suppuration following the use of 5 per cent collargol as a pyelographic medium. He maintained that under increased pressure, the collargol passes into the canaliculi and thence by rupture or diffusion reaches the perirenal tissues causing necrosis. In 1 case, the rupture occurred in the pelvis of a hydronephrotic kidney and spread into the peritoneal cavity. Kindall has recently reported 2 interesting cases of rupture following syringe pressure pyelograms. In 1 patient a calculus was present in the lower calyx of the kidney and a rupture of the kidney occurred and 2 days later a rupture of the ureter. The other patient had calculi in the kidney pelvis and ureter and developed a rupture of the pelvis.

PATHOLOGY

The pelvic lesion encountered at operation or autopsy may be either a laceration or a perforation on one of the surfaces of the pelvis, usually the posterior surface. Occasionally two tears may be present in the same pelvis. The laceration or tear in the pelvis is usually radial in character especially in cases of a ruptured hydronephrotic pelvis and appears to extend from a point near the ureteropelvic junction toward the hilum of the kidney in a direction corresponding to that of the uriniferous tubules. The size of a tear is more or less in proportion to the degree of back pressure and increased intrapelvic pressure causing the rupture. The nature and the direction of the pelvic laceration in these cases tends to indicate that the lesion is the result of a bursting rather than a break or crushing. This conforms with Kuster's theory on the mode of kidney rupture.

A pathologically or physiologically distended kidney pelvis ruptures more easily and following a lesser degree of violence than a normal undistended kidney. Furthermore, the extrarenal type of pelvis is more susceptible to rupture than the intrarenal type. In cases of rupture of a normal

kidney due to external violence, the parenchyma, being the softest and weakest portion of the kidney usually gives way first causing a tear which may extend into the capsule. However if the pelvic wall has been weakened by a chronic infection or hydronephrosis, the rupture may be strictly limited to the pelvis. Occasionally it may involve both the pelvis and the parenchyma. Spontaneous rupture of the kidney pelvis occurs only in those cases in which the pelvis has been pathologically weakened by dilatation or infection. The most common type of spontaneous rupture is rupture of the pelvis of a hydronephrosis secondary to an obstruction of the ureter or pelvis by a calculus. The rupture occurs as a result of a sudden or gradual alteration in the increased back pressure caused by an obstructive lesion in the upper urinary tract. Occasionally a spontaneous rupture of the pelvis is caused by perforation of an impacted calculus. There have been no cases reported of spontaneous rupture secondary to a neoplasm of the renal pelvis.

Several cases have been reported in which the pelvis or ureter at the ureteropelvic junction have been partially or completely severed as a result of violence or external force directed against the distended kidney. It may be impossible to differentiate the rupture of the pelvis from a similar lesion of the upper portion of the ureter from a clinical standpoint. However from an anatomical standpoint, a tear or perforation at the ureteropelvic junction may be considered just as much a lesion of the pelvis as of the ureter. In fact, it is often impossible to determine on close inspection of the affected organ, either at operation or at autopsy, the exact location or limitation of the rupture. A careful survey of the literature reveals the fact that true intraparietal rupture of the ureter is an exceedingly rare condition.

The most striking pathological feature of ruptured pelvis is the extravasation of urine into the surrounding tissues. This condition is rarely accompanied by the extravasation of blood inasmuch as there are no end arteries in the pelvis. The presence of blood in the extravasate is indicative of rupture of the parenchyma or a laceration of one or more of the blood vessels in the hilum of the kidney. It is possible that at the time of rupture of the pelvis there may develop an intrarenal rupture in the region of the pyramids of varying degree which may be responsible for a slight amount of bleeding and the presence of a small amount of blood in the extravasate.

When the actual amount of urine escaping through the pelvic rupture or perforation is scant and the urine sterile the tissue reaction is prompt

and localization of the extravasate may ensue with or without the subsequent formation of a circumscribed abscess in the peripelvic or perirenal tissues. If the extravasated urine is walled off and absorbed, these patients may recover without any surgical intervention and it is conceivable that cases of this type occur but are not recognized.

When the extravasation of urine is more extensive or continues for some period of time after the rupture, the tissue reaction may be less efficient particularly if the urine contains pathogenic organisms. In such a case the extravasated urine causes a diffuse inflammation in the surrounding tissues which soon results in suppuration and a rapidly progressive perirenal abscess. Occasionally the perirenal abscess may rupture into the lung (Mathe) large bowel (Wesson) peritoneal cavity (Hammel, Roet, Kapel) or externally into the skin of the loin giving rise to the formation of a temporary or permanent fistula (Mathe, Turner Higgins, and Hicken, and one of the authors' cases).

Vermooten and McKeown recently reviewed 34 cases of renal colic fistula. In 2 instances (Watson and Cunningham, Fuller) the fistula was found between the renal pelvis and the bowel. In all the other cases, the fistulous tract started in a calyx passing through the kidney substance into the bowel. They pointed out that renocolic fistulae are always secondary to long standing suppurative lesions of the kidney which, as a rule, are associated with either a chronic pyelonephritis or a perinephritic abscess.

The author has reviewed the cases of fistula formation between the renal pelvis and the large and small bowel or bronchus reported in the literature and has recorded them under their respective headings in the bibliography. These cases are not included in the final tabulation of true cases of ruptured pelvis due to the fact that the etiological relationship is by no means clearly established in these cases.

The immediate pathological changes occurring in the affected kidney following a pelvic rupture depends upon the condition of the kidney before the injury and the extent of the inflammatory process in the perirenal tissues following the injury. The subsequent perirenal infection may assume the characteristics of an extensive gangrenous process or a devastating phlegmon which soon involves the entire perirenal tissues. The infection may invade the kidney proper and produce many cortical abscesses or a diffuse pyelonephritis.

The permanent pathological sequelae which may follow the rupture of the pelvis depend

upon whether or not treatment is instituted. In those patients who recover without operative intervention due to the fact that the extravasation is slight and localization with absorption takes place there may develop a cicatrizing or sclerotic process in the perinephritic tissues which may or may not cause trouble in the future. Occasionally the reparative process in the region of the tear is faulty and there develops a stenosis which may be responsible for the further development of a hydronephrosis or even stone formation. If treatment consists solely of preliminary incision and drainage and no attention is paid to the underlying lesion the after effects of the rupture resulting from the suppurative process in the perirenal tissues may be manifested in the form of a permanent fistula kidney atrophy infection of the opposite kidney parenchymatous or interstitial nephritis, or future stone formation. In those cases in which the rupture of the pelvis occurs in the form of a partial or complete severance or tearing of the pelvis at the ureteropelvic junction or in which the pelvis is completely severed from its attachments at the hilum of the kidney primary healing is not likely to occur and there results a permanent fistula. In an occasional case, the injured tissues may heal with cicatricial contraction at the site of rupture which results in a partial or intermittent form of hydronephrosis as occurred in the case which has been reported by Bailey.

While this paper is particularly concerned with rupture of the kidney pelvis proper it is interesting to note that rupture of the pelvis may also occur in any of its major or minor calyces. When the calyceal rupture is due to trauma, the laceration may extend partially or completely through the adjacent parenchyma (subparietal rupture) which results in an extravasation of blood and urine below the true capsule of the kidney and heals with little or no permanent damage to the kidney. Occasionally the calyceal rupture results in a distention of the calyx due to an intrarenal extravasation of urine which may extend through the cortex and under the kidney capsule. This process soon becomes walled off producing a cystic dilatation whose lining appears to be a continuation of the pelvic and calyceal mucous membrane. This walled off sac is known as a pseudohydronephrosis which may later rupture as in the case reported by Babitzki. In the same manner a pseudohydronephrosis may develop following a rupture of the true pelvis. This condition occurred in 6 cases of traumatic rupture (Hawkins, Stanley, Dodge, Wildbolz, and Bretnanno 2 cases).

AGE AND SEX INCIDENCE

The age and sex of the patients bear no unusual significance in cases of ruptured pelvis. The age and sex act as predetermining factors only in so far as they predispose to the development of an upper urinary tract lesion which increases the susceptibility of the kidney pelvis to ruptures. i.e. the development of a congenital hydronephrosis in infants and children the occurrence of pyelitis of pregnancy hydronephrosis ptosis and stone formation in women in the childbearing period. There were 4 cases of traumatic rupture in the first decade (Hawkins, 6 years, McAlpine, 7 years, Weason, 8 years and Martin 8 years) and 4 cases in the second decade (Croft, 12 years, Lazarus, 15 years, Ewell 16 years and Rowland 18 years). The youngest patient in the series of cases reviewed was 6 years of age (Hawkins) the oldest 77 years (author's case). The average age was 35.6 years. There were twice as many males (39 cases) as females (19 cases). This latter observation may be explained by the fact that the greatest number of cases were of the traumatic type and in this age of automobiles, trains and machinery and of competitive sports, men are subjected to greater hazards than women. The left kidney was the site of the pelvic rupture in 35 cases and the right kidney in 22 cases. There was 1 case of bilateral rupture (avulsion) reported by Osgood and Campbell.

SYMPTOMATOLOGY

There is no definite symptom complex associated with rupture of the kidney pelvis inasmuch as the presenting symptoms may differ in the traumatic and spontaneous types of pelvic rupture. The clinical signs and symptoms associated with this condition vary and are more or less dependent upon the etiological factor producing the lesion the associated pathological process present in the affected kidney and the length of time elapsing until the patient first comes under observation. In general it might be stated that the most prominent signs and symptoms of ruptured pelvis are those attributable to perirenal extravasation of urine and perirenal abscess formation. The symptoms of ruptured pelvis may be conveniently classed into the following two groups: general and localized.

General. From a clinical standpoint, ruptures of the pelvis may be divided into an acute and chronic form. The acute group includes those cases of sudden rupture of the pelvis secondary to trauma. In the acute form the patient appears to be acutely ill soon after the rupture has occurred as a result of the sudden escape of urine producing



Fig. 3. Case 2. Pyelogram taken in 1933. The pelvis and ureter of the upper rudimentary segment of the left double kidney has been filled with sodium iodide (13.5 per cent). The large branched calculus occupying the pelvis of the lower segment of the left kidney is clearly shown. The round shadow in the region of the upper pole of the right kidney is a calculus. A pyelogram of the right kidney which was taken several weeks later showed a moderate dilatation of the pelvis and the calculus in the terminal portion of the upper major calyx. Further pyelographic studies of the left double kidney showed a large pyonephrosis of the lower segment but the roentgenograms were too faint for photographic reproduction.

resumed as soon as the initial shock wears off. In cases of ruptured pelvis, the fact that urine is not obtained from the injured kidney may be incorrectly attributed to anuria, whereas the kidney may still retain its secretory function and urine, instead of passing down the ureter, extravasates in the perirenal tissues, and occasionally in the peritoneal cavity or bowel (Wesson, Mathe). A true unilateral anuria on the affected side may develop as a result of the pressure effect of the perirenal extravasation upon the renal pedicle.

Such urinary symptoms as urgency, frequency, dysuria, and tenesmus are uncommon. The occurrence of these symptoms would tend to indicate the presence of an associated obstructive lesion at the bladder neck or a secondary inflammatory lesion in the bladder. Hematuria is conspicuous

by its absence in cases in which the rupture is strictly confined to the pelvis in contradistinction to rupture of the parenchyma in which instance it is a very important diagnostic sign. If the rupture of pelvis is due to trauma and there is a minute intrarenal parenchymal tear or a rupture of a small intrarenal blood vessel in or near the pelvis, i.e. small blood vessel in the pyramids, hematuria may occur at the time of a rupture but soon clears up. The urinary findings are most commonly those associated with an acute progressive toxemia, i.e. a trace of albumin, an occasional red or white blood cell and casts.

DIAGNOSIS

The diagnosis of ruptured pelvis is always difficult. A review of the literature reveals the fact that the majority of the reported cases remained undiagnosed until the time of operation or at autopsy due to the rarity of the condition and the uncertainty of the clinical signs and symptoms. In those few cases in which a correct pre-operative diagnosis was made, it was necessary to resort to other diagnostic measures, i.e. cystoscopy and pyelography to establish the diagnosis.

A careful history in every case may be of inestimable assistance in directing the examiner to the possible existence of such a lesion. An antecedent history of renal colic due to stone in the ureter or pelvis is of definite significance, particularly in cases of rupture secondary to calculus obstruction of the ureter. The knowledge of the presence of an inflammatory or obstructive lesion in the upper ureter or pelvis secondary to a stone or stricture in the upper urinary tract in a patient who complains of a sudden severe pain in the renal region and presents a palpable tender mass with muscular rigidity and spasticity over the affected area, accompanied by chills, fever, nausea and vomiting and rapidly followed by signs of collapse or a severe toxemia, should cause the examiner to suspect a rupture of the pelvis, though actually the diagnosis must be confirmed by pyelographic study or operation. It may even be impossible to establish the diagnosis when cystoscopy and pyelography are undertaken inasmuch as the offending calculus may totally occlude the ureter or ureteropelvic junction rendering it impossible to pass a ureteral catheter or inject a pyelographic medium beyond the obstruction.

Cystoscopy with bilateral ureteral catheterization has proved to be one of the most valuable diagnostic procedures available. Cystoscopic examination is often undertaken in the hope of relieving an acute renal infection or a ureteral

block with acute retention of urine in the pelvis and the true nature of the upper urinary tract lesion is then disclosed. When the catheter fails to reach the kidney pelvis due to an obstructing ureteral calculus, the urologist may be misled into believing that the calculus is the sole lesion producing the symptoms and may overlook the more serious lesion in the kidney pelvis. Thus, the correct diagnosis of pelvic rupture with perirenal extravasation is undetermined or discovered later at operation or autopsy. If the catheter can be passed into the kidney pelvis or zone of extravasation clear urine or actual pus may be obtained which should make the urologist suspicious of a pelvic rupture. The rate and amount of urine flowing from the catheter on the affected side should be carefully observed. A large amount of urine aspirated from the perirenal space through the pelvic tear is a presumptive diagnostic sign of ruptured pelvis. In some cases the urologist is tempted to and does leave the catheter in the pelvis for several days in the hope that drainage of the infected area will result in a subsidence of fever and sepsis and postpones pyelography and operation until a later date with serious consequences.

Differential renal functional tests (phenolsulphonphthalein, indigo carmine, methylene blue etc.) are of little value in establishing the diagnosis of ruptured pelvis or in determining the function of the injured kidney. The same may be said of the value of blood urea, non protein nitrogen etc. As a result of a pelvic tear or perforation, the urine escapes into the perirenal tissues and very little passes down the ureter with a consequent inaccurate determination of renal function. The result of these tests may show a complete loss of function in the affected kidney which may only be temporary if the rupture occurs in a congenitally normal kidney and permanent if the rupture occurs in a diseased kidney.

There appears to be a divergence of opinion as to the wisdom of employing pyelography in the diagnosis of injuries to the kidney parenchyma and pelvis. Luckett and Friedman strongly urged its use in the diagnosis of kidney injuries. They pointed out that the location and extent of kidney injury could be determined by the dissemination of the pyelographic medium within the kidney substance or outside the confines of the kidney pelvis or capsule. They also emphasized the fact that from the pyelographic findings it is possible to determine whether surgical interference is necessary without waiting for secondary symptoms or complications as an indication for such



Fig 4. Case 3. Photograph of the left double kidney removed at autopsy. The arrow points to the perforation in the posterior aspect of pelvis of the lower segment. The large branched calculus occluding the intrarenal portion of the lower pelvis can be seen. The lower kidney segment shows the typical changes of a large multilocular pyonephrosis. The upper rudimentary segment is seen beneath the scale and shows relatively little change in the parenchyma. The small pelvis in the upper segment and a portion of partially duplicated ureters may also be seen.

interference. Beach maintained that pyelography is a harmless procedure and should be employed immediately in every case of suspected kidney injury. Herman and Wallenstein emphasized its value in the diagnosis of ruptured hydronephrosis and Geisinger stressed its importance in the diagnosis of extravasation from the ureter.

It is quite obvious that pyelography should never be attempted in those patients who are critically ill or in shock. In the past, the objection to pyelography was based on the supposed danger attending the injection of an irritating pyelographic medium i.e., sodium iodide, into an injured kidney or into the perirenal tissues. Fritz and Geisinger maintain that the distribution of a small amount of sodium mercuric iodide into the tissues already infiltrated with pus and urine is not likely to be productive of any serious sequelae particularly if very low pressure (gravity method) is used in injecting the pyelographic medium. The danger of injecting an irritating electrolyte (sodium iodide) into the perirenal tissues can be readily obviated by employing 15 per cent skiodan which is non-toxic, non-irritating and non-haemolytic. Hartman and Kindall have pointed out that the usual criteria i.e., pain and volume of pyelographic medium injected are usually insufficient to judge over distention in a traumatized kidney where the

dition demanding prompt and efficient treatment. Immediate incision and drainage of the perirenal tissues is imperative and, in fact, may even be life saving in effect. After preliminary drainage has been established the true nature of the condition or the underlying cause can be determined later or not as circumstances dictate.

Death may occur as a result of this severe infection, toxemia, or septicemia. If the patient survives the initial stage complications may ensue, viz. the perforation of the perirenal abscess into the peritoneum, abdominal viscera or through the diaphragm, and the patient succumbs after a protracted period of wasting and suffering. The presence of an associated intra-abdominal lesion or a peritoneal tear occurring at the time of the pelvic injury offers a most unfavorable prognosis. The presence of a disease process in the opposite uninjured kidney may seriously endanger the patient's life inasmuch as the injured kidney in most instances is damaged beyond repair and the entire secretory burden is thrust upon an impaired organ. As far as we have been able to ascertain, there are no cases reported in which a simultaneous bilateral rupture of the kidney pelvis occurred with the exception of Campbell's two cases: chemical necrosis following the intrapelvic injection of sodium hydroxide and bilateral avulsion of pelvis following a fall. Such an accident would almost certainly lead to an early demise.

According to Morris, the prognosis in cases of rupture of the renal parenchyma, renal pelvis or ureter is less favorable than in rupture of any abdominal viscera. This pessimistic attitude may be attributed to the fact that the high mortality figures associated with rupture of any portion of the kidney in the past were based on the reports of isolated cases or series of grave cases. However, the recent refinements in urological and roentgenological diagnosis and the improvement in surgical technique have been responsible for a marked reduction of the mortality and morbidity of this condition. In the series of cases collected by the author the immediate operative mortality was 6 per cent (3 deaths in 50 operative cases) which is a very modest figure when one considers that they include cases in which preliminary drainage was delayed intentionally or non-intentionally by the patient or the surgeon.

CASE REPORTS

CASE 1: N. M., a man 77 years of age, an inmate of the Aged Home, was admitted to the hospital on May 6, 1913, with the complaint of pain in his left kidney region. He had had a bilateral ligation of the vas deferens and a perineal prostatectomy 1 year previously with an excellent functional result. Four weeks before admission to the

hospital the patient developed a sudden sharp pain in his left lumbar region radiating to the groin. The pain persisted for several hours and was accompanied by nausea, vomiting and fever. A dull pain persisted in the left lumbar region and left upper quadrant after the first attack. The patient gave a history of nocturia (1 to 3 times) burning, hesitancy and urgency but no history of passing a calculus or hematuria or trauma.

Physical examination was negative except for definite fulness in the left upper quadrant extending from the left flank to the mid-epigastrium. A mass about the size of a large orange was felt and appeared to be smooth and tender to touch. There was no ballottement or fluctuation. There was tenderness in the left costovertebral angle. The leucocyte count was 10,000 with 86 per cent polymorphonuclears. The urine showed 30 to 30 pus cells per high power field.

Following admission to the hospital the temperature remained slightly elevated for 4 days. Cystoscopy and pyelography were then performed. Two small calculi in the bladder were seen and removed by a rongeur. Pyelogram of the left kidney showed extravasation of dye around the pelvis of the kidney. The pelvis and calyces appeared to be dilated. A tentative diagnosis of left pyonephrosis with a peripelvic abscess due to rupture of the pelvis was made. He was kept under observation for several days but as he continued to show a slight daily elevation in temperature and the mass appeared to be increasing in size and became more tender on palpation, operative intervention was decided upon. Fourteen days after his admission to the hospital a subcapsular nephrectomy was performed under spinal anesthesia. The abscess contained approximately 3 ounces of a thick, green, foul-smelling pus which was found on the posterior aspect of the lower pole of the kidney and extended around anteriorly to the region of the pelvis. Two perforations were noted in the region of the ureteropelvic junction. Culture of the pus from the abscess revealed *Bacillus pyocyaneus*. The patient had a stormy convalescence for the first few weeks after operation. The wound broke down and the patient developed furuncles in the left lumbar region culminating in a fairly large carbuncle, which responded slowly to treatment. He was discharged from the hospital 34 days after operation in good condition with the wound entirely healed except for a small sinus tract which healed 3 weeks later.

Pathological examination showed the usual changes of arteriosclerosis and pyonephrosis. The ureter was constricted at the ureteropelvic junction. Above this point of constriction, there was a small perforation 3 millimeters in diameter and a millimeter in diameter respectively.

It is difficult to determine the etiological factor responsible for the perforations of the pelvis and ureter in this case. It is the author's opinion that the essential pathological changes present in the affected kidney i. e. pyonephrosis, pyelonephritis, and stricture of the ureteropelvic junction, were secondary to the benign prostatic enlargement which was removed 1 year before. The perforations in the pelvis were probably the result of increased back pressure beyond the stricture at the ureteropelvic junction. It is difficult to explain the development of the perforations below the ureteropelvic junction unless these perforations are the result of an attempt of extravasated urine and pus to drain back into the ureter.

CASE 2. K. Z. 53 years of age a housewife, was admitted to the hospital on June 23, 1933, with the complaint of pain in the left upper quadrant. The patient gave a history of kidney colic on the right side in 1926. She subsequently developed kidney colic on the left side in 1928. In March, 1928, a right nephrolithotomy was performed. At this time pyelographic studies also revealed a large calculus present in the lower and larger half of a double kidney on the left side. There was an incomplete duplication of the ureter on the left side with bifurcation at the middle and upper third of the ureter. Operative removal of the left renal calculus was deemed inadvisable because of the marked infection present in both kidneys and the reduced renal function in each kidney. From 1926 to 1933 she received about 75 cystoscopic treatments in the form of bilateral ureteral dilations and pelvic lavages at intervals of 2 to 4 weeks.

For 3 weeks previous to admission the patient had been confined to bed because of marked weakness and severe pain in the left upper quadrant. She also complained of chills, fever, nausea and vomiting. The urine had been very cloudy and at times blood tinged. The patient complained of frequency every hour during the day and nocturia 1 to 3 times, burning on urination, urgency and tenesmus. She noticed a swelling of the left upper quadrant for the previous 2 weeks, which gradually increased in size. She was also troubled with abdominal distention, flatulence, eructation, and constipation.

On examination the patient appeared to be acutely ill and very toxic. There were no evidences of shock or collapse. Cardiac findings were those of mitral insufficiency and arteriosclerotic heart disease. There was a swelling in the left upper quadrant with spasticity and rigidity of the overlying muscles. It was impossible to outline a definite mass in this area. There was exquisite tenderness in the left upper quadrant, left loin, and left lumbar region.

The urine gave a strongly positive test for albumin and microscopically showed a large number of pus cells, an occasional red blood cell, granular casts and organisms which proved to be *Bacillus coli*. The leucocyte count was 9,400 and 75 per cent polymorphonuclears. The blood urea was 70 to 75 milligrams per cent. Intravenous phthalein was reported as 10 per cent for the first hour and 15 per cent for the second hour.

A diagnosis was made of an acute exacerbation of a calculous pyonephrosis involving the lower half of the left double kidney. The signs and symptoms pointed to the presence of an accompanying perinephritic abscess on the left side. Due to the fact that the patient appeared to be critically ill, cystoscopic and pyelographic studies were not carried out. Immediate operation was advised upon admission to the hospital, but the family refused permission until 10 days after admission when the patient appeared to be moribund. She was given a pre-operative transfusion of 500 cubic centimeters of citrated blood. Ten days after admission to the hospital an exploratory lumbar incision was made under spinal anesthesia and a large perinephritic abscess was found surrounding the entire kidney and containing about 3 quarts of a thick, greenish pus which on culture was reported as *Bacillus coli*. The abscess extended up to the diaphragm and down to the pelvic brim, but had not broken its way through the overlying muscles. Extensive drainage of the abscess area was provided. Due to the poor condition of the patient it was decided not to explore the kidney or to attempt to remove the kidney. Following the operation, the patient appeared to rally somewhat, but on the third postoperative day became stuporous and semicomatose and died the following morning.

A partial autopsy was performed which disclosed a double kidney on the left side with an incomplete duplica-

tion of the ureter. The upper supernumerary segment of the double kidney appeared to be relatively normal on gross examination and cross section. The lower segment was a massive multilocular pyonephrosis. The pelvis of the lower segment was covered with a large amount of fibroplomatous tissue which was diffusely inflamed. At a point on the posterior surface of the pelvis corresponding to the mid-portion of the lower segment there was found a perforation from which thick greenish pus exuded. On cross section of the lower segment there was a large branched calculus occupying the extrarenal portion of the pelvis of this segment. There was an area of necrosis about the perforation. The right kidney was of the hypoplastic type and showed arteriosclerotic changes.

The etiological factor responsible for the perinephritic suppuration was a perforation of the chronic inflamed pelvis by a large irregular calculus. In our review of the literature we have not found a similar case of perforation of the wall of the pelvis of one segment of a double kidney. Undoubtedly, the prognosis in this case would have been more favorable if drainage of the abscess had been instituted immediately. The lack of co-operation on the part of the patient's family in consenting to an operation also contributed considerably to the fatal outcome in this case.

CASE 3. J. P. 53 years of age married, male merchant, was admitted to the hospital on May 28, 1933, with the complaint of pain in the left abdomen. The past history was negative except for a chronic gastro-intestinal complaint for the previous 10 years in the form of attacks of cramp-like pain in the left lower quadrant. The patient was admitted to the hospital for a thorough study and during the course of the examination was found to have some pus and red blood cells in his urine. He gave a history of occasional diurnal frequency every 1 to 1½ hours, and nocturia, 1 to 3 times, hesitancy and occasional burning on urination. There was no history of hematuria or renal colic.

Physical examination was essentially negative except for a slight tenderness in the left upper quadrant over the left kidney. A positive left ureteral point was present. The prostate was of normal size.

A complete urological study was undertaken and disclosed (1) median bar formation and (2) left hydronephrosis, third degree, infected and non-functioning. A plastic operation on the pelvis of the left kidney was performed under spinal anesthesia. An elliptical piece of tissue was removed from the superior and inferior aspects of the pelvis and a Heinecke Mikulicz repair was done at the uretero-pelvic junction. The patient made an uneventful recovery. About 1 month after operation a cystoscopic and pyelographic study was made and revealed a marked reduction in the size of the left hydronephrosis with a definite restoration of function in this kidney.

Eighty days after operation he developed a sudden pain in his left loin followed by a chill, nausea, vomiting and fever. Some relief was obtained by an application of heat to his left loin. Four days later he had another chill and was seen for the first time following the operation. At this time an area of fluctuation was noticed in the upper angle of his incision. There was tenderness in this area. There was no history of trauma. A tentative diagnosis of rupture of the pelvis with extravasation of urine was made and the patient was sent into the hospital.

Pyelographic examination revealed dilatation of the left pelvis with an extravasation of dye outside the kidney pelvis. Ninety three days after the previous plastic operation on the pelvis, incision and drainage was performed at the site of the old sinus tract and 50 cubic centimeters of a foul-smelling, sero-sanguinous material escaped. Three days later a left nephrectomy was performed under spinal anesthesia. The patient made an uneventful recovery and was discharged from the hospital with the wound entirely healed.

Examination of the left kidney showed diffuse pyelonephritic involvement of the kidney substance with a diffuse cortical abscess formation, also a marked perinephritis was present. At the ureteropelvic junction, which was the site of the Henckels-Mikulicz repair, there was a very marked narrowing of the mucosa, producing almost complete obstruction. There was a perforation in the line of the suture.

The cause of the perirenal extravasation of urine in this case was the failure of the suture line to hold following plastic repair of the stricture at the ureteropelvic junction and the development of a postoperative stricture and subsequent perforation at this point. Obviously the suture line held for a short time after operation for a pyelographic study performed 35 days after operation showed no extravasation of dye. However it is possible that the suture line was weakened as a result of the postoperative pyelographic study undertaken to check the result of the operation. Intravenous urography for this purpose should preferably have been employed.

TREATMENT

The keynote of success in the treatment of rupture or perforation of the kidney pelvis is immediate operative intervention. The type of operative treatment may be either conservative or radical since no hard or fast rules can be laid down to apply to every case. There are several factors which require careful consideration and which may greatly influence the surgeon in his choice of operative therapy. These factors are: (1) the early recognition of the true nature of the disease; (2) the general condition of the patient; (3) the time elapsing between the pelvic rupture and the diagnosis of the condition and institution of operative treatment; and (4) determination of the pathological condition of affected kidney and condition of the opposite kidney. If the patient has been under observation for some time due to the uncertainty of the diagnosis or to the failure of the physician to recognize the serious nature of the condition, the operative treatment may vary depending upon the secondary pathological complications developing in the course of operative therapy. The final decision as to the type of operation as a very careful and rational pre-operative plan

of therapy may be disorganized by the pathological findings encountered at operation. I.e. extent of extravasation of urine and suppuration in the perirenal tissues, and the presence of a severe disease process in the damaged kidney.

The most important step in the surgical treatment of ruptured pelvis is prompt and adequate drainage of the extravasated urine or pus in the perirenal tissues. This procedure is a veritable life-saving measure as it assures proper elimination of urine and pus from the perirenal tissues, relieves the patient of toxic absorption of urine, fibrin and tissue ferments, enables the patient to regain strength and recover from shock. All other steps in the operative treatment can be postponed or delayed if necessary without jeopardizing the life of the patient.

Occasionally the immediate institution of the drainage of the perirenal tissues is sufficient to effect a cure. It is conceivable that such a favorable outcome may be obtained in the case of a traumatic rupture of the pelvis of a congenitally normal kidney in which the perirenal extravasation of urine is handled efficiently. In such a case, perirenal suppuration is absent or very slight and penneal suppuration is absent or the pelvic fistula closes clear up entirely and the pelvic fistula closes spontaneously. It is very important that the surgeon should expose the entire kidney if possible and make a careful examination of the kidney in order that any additional tears or rupture in the renal parenchyma, pelvis, vascular pedicle and posterior peritoneum are not overlooked or neglected.

The ideal conservative form of treatment combines incision and drainage of the perirenal tissues with repair of the rupture or perforation of the pelvis and correction of the pathological process responsible for the rupture. While this plan of treatment is in keeping with the trend of modern renal surgery toward the conservation of the kidney it is not always possible or advisable to adhere to this type of treatment. In reality there are relatively few cases of ruptured pelvis that lend themselves to such conservative operative therapy. This procedure was employed in 2 cases (Rowland Cowden). In the majority of instances, the extravasation of urine has proceeded on to frank suppuration and the kidney shows signs of severe damage, so that any attempt to save the kidney in the presence of a severe suppurative process in the kidney and surrounding tissues may jeopardize the patient's life or prolong the convalescence unnecessarily. However there is a small percentage of cases in which this type of conservative treatment is recommended and urged. When the patient is operated upon within

a few hours after a rupture of either the spontaneous or traumatic type and the kidney does not appear to be badly damaged by a pre-existing pathological process, and the extravasation of urine is scant and well localized, conservative treatment is indicated and yields good results. This type of treatment is particularly applicable to those cases with small lacerations or perforations secondary to an impacted calculus in the pelvis or upper third of the ureter in which the removal of the obstructing calculus, repair of the pelvic laceration and drainage of the renal bed can be quickly and efficiently accomplished. This type of treatment was successfully employed in 7 cases (Legueu, Mathe and Ovideo Turner Beach, Crane, Mathe, and Wesson). In removing the offending calculus it may be necessary to enlarge the site of rupture or perforation and convert it into a pyelotomy incision which can readily be closed by suturing.

While it may seem to be a logical and ideal procedure to attempt a plastic repair of pelvic laceration at the time of preliminary drainage such a procedure is always difficult and frequently impossible in the presence of an inflammatory and infiltrating process in the perirenal tissues or dense peripelvic adhesions resulting from the extravasation of urine and pus. Experience has shown that the success of plastic operation on the renal pelvis depends upon careful planning and aseptic operative conditions. Furthermore it is folly to attempt a plastic operation on the pelvis without a previous determination of the condition of the kidney or ureter on the affected side either before or at the time of operation since it is difficult to conceive how any form of repair can be expected to hold under pressure proximal to an unrecognized ureteral obstruction.

The radical type of treatment in cases of ruptured pelvis is combined removal of affected kidney and drainage of perirenal tissues, provided the opposite kidney is normal. This type of treatment was employed in 14 cases without a death. Inasmuch as the kidney presenting a pelvic rupture is practically always considerably damaged or totally destroyed by back pressure (hydronephrotic atrophy secondary to calculous obstruction) or suppurative processes (pyelonephritis), nephrectomy assures the removal of the focus of infection and the elimination of the cause of extravasation of urine and pus into the perirenal tissues and the development of unpleasant and serious sequelae can be avoided. In the final analysis this form of treatment may prove to be most conservative from the standpoint of saving the life of the patient preventing postoperative complica-

tions and shortening the period of convalescence. Not only is nephrectomy indicated in those cases of pelvic rupture in which the kidney is destroyed by back pressure or a chronic inflammatory and suppurative process but also in those cases in which the pelvic rupture is accompanied by an associated injury to the vascular pedicle or an extensive and severe laceration of the parenchyma. Nephrectomy should also be performed in those cases in which there is an extensive rent in the pelvis that cannot be sutured as in the case of a large hydronephrosis, or the pelvis has been avulsed from its attachments at the hilum, or the ureter has been completely torn across at the ureteropelvic junction and repair is difficult due to peripelvic inflammation.

Mathe has stressed the importance of performing a two-stage operation consisting of preliminary incision and drainage followed by secondary nephrectomy at a later date in the advanced cases presenting signs of shock, collapse or severe toxæmia. This type of treatment was employed in 10 cases without a death. The exercising of such judgment often is the determining factor in obtaining both a live patient and a good functional result. As many of the patients with ruptured pelvis appear to be debilitated and toxic from the accompanying perirenal suppuration, it is readily understood why primary nephrectomy under these conditions is fraught with danger and likely to terminate fatally. Primary incision and drainage serves to control and minimize the danger of the perirenal suppuration and enables the patient to recover before a secondary operation, either nephrectomy or conservative repair, is undertaken. Furthermore, the urologist may take advantage of the period of convalescence following preliminary incision and drainage to undertake a thorough urological study to determine the cause of the pelvic rupture and plan the operative procedure necessary to correct or remove the causative lesion. In the very sick patients, it is important that the preliminary incision and drainage be done with as little manipulation as possible in order to preserve the natural barriers and to avoid dissemination of the infection.

The choice of the secondary operative procedure to be performed depends upon a variety of possible circumstances which make generalizations impractical. As indicated above, in an occasional case the perirenal suppurative process may clear up entirely and the pelvic fistula may close spontaneously thus eliminating the necessity of a secondary operation. In those cases in which the integrity of the pelvis or the continuity of the ureter or pelvis has been interrupted by partial or

complete circular laceration clitoral stenosis, or destructive process, the pelvic fistula may persist and a conservative plastic operation on the renal pelvis may suffice to effect a cure. However, it is very likely that even under these favorable circumstances, the destructive process in the affected kidney, has impaired the kidney function to such an extent that the improvement in the function of the affected kidney following plastic operation is so slight that infection or stasis soon ensue necessitating subsequent nephrectomy.

Obviously in those cases in which evidence of bilateral renal disease has been previously determined preliminary incision and drainage is indicated pending a more complete investigation of both kidneys. This type of treatment was employed in 2 of 3 fatal cases which were moribund at the time of operation. In cases of ruptured pelvis complicated by bilateral renal insufficiency or bilateral hydronephrosis, temporary pyelotomy or nephrostomy or decapsulation at the time of preliminary incision and drainage may be an extremely valuable measure and may preserve the function of the kidney until some final corrective procedure is carried out.

Occasionally the presenting symptoms may be so strongly suggestive of an intra-abdominal lesion that an exploratory laparotomy to rule out such a lesion was performed (Dodge, Rowland, McAlpine, Hammel) before exposing the kidney through the usual lumbar incision. It is well to point out that infrequently the ruptured pelvis, especially in the spontaneous type, may be accompanied by a peritoneal perforation with peritonitis and it may be advantageous to approach or remove the kidney by the transperitoneal route and at the same time provide drainage of the perirenal tissue through a stab incision in the loin.

The question of anesthesia is an important one. When preliminary incision and drainage is performed in patients who are critically ill or moribund, the operation should be done under local infiltration anesthesia. If the patient's general condition is good and symptoms of shock or toxemia are absent, spinal anesthesia, using 50 to 100 milligrams novocain may be employed with safety as in 2 of the author's cases. Inhalation narcosis with ether whose cardiac stimulative powers are well known should be employed in those cases presenting threatening signs of vascular collapse or showing a low cardiac reserve.

CONCLUSIONS

A review of 64 cases of ruptured pelvis collected from the literature and the author's experience

with 3 personal cases warrants the following conclusions:

1. Rupture of the kidney pelvis proper is a relatively rare condition. The rupture may be of the traumatic or spontaneous (non-traumatic) type.

2. The traumatic type of ruptured pelvis may occur in a congenitally normal kidney or in an acquired inflammatory (chronic pyelonephritic) or obstructive (hydronephrotic) kidney. The rupture is usually the result of direct or indirect trauma exerted against the kidney in such a manner that the physiologically or pathologically distended or chronically inflamed pelvis is jammed against the lower ribs or the transverse processes of the upper lumbar vertebrae as maintained by Kuster. The rupture is usually linear and radial in character. The degree of external violence varies from a crushing injury to an indirect blow in cases of rupture of a hydronephrotic pelvis.

3. The spontaneous type of pelvic rupture practically always occurs in a kidney which is the seat of a chronic pyelonephritic process or whose pelvis is dilated as the result of a ureteral or pelvic obstruction. The most common type of spontaneous rupture is the rupture of the pelvis of a hydronephrotic kidney secondary to an obstruction of the ureter or pelvis by a calculus or stricture. The rupture occurs as the result of a sudden or gradual alteration in the increased back pressure caused by an obstructive lesion in the upper or lower urinary tract. Perforation of the pelvis resulting from pressure necrosis of an impacted calculus is another frequent type of spontaneous rupture.

4. Rupture of a pathologically weakened pelvis may also occur as the result of instrumental perforation or follow the exertion of increased pressure in the syringe method of pyelography. In rare instances, perforation may be due to chemical necrosis following the injection of a strong alkali by mistake during pyelography or renal lavage.

5. The traumatic type of rupture has a greater incidence than the spontaneous type. The traumatic type apparently occurs with greater frequency among the males which may be due to the fact that males are subjected to greater hazards in this age of highly mechanical industries, automobile travel, and competitive sports. The spontaneous type occurs with about equal frequency in both sexes. The traumatic type may have a greater incidence in children due to increased susceptibility of a pathologically weakened pelvis in children to rupture following mild trauma which may be attributed to the persistence of

infantile ptosis and lack of bony protection of the ribs.

6 There is no definite symptom complex or clinical syndrome that is absolutely typical or constantly associated with rupture of the pelvis. The urologist should suspect a rupture of the pelvis if patient gives an antecedent history of chronic pyelonephritis or hydronephrosis secondary to calculus in the pelvis or ureter and presents the following train of symptoms, viz., sudden sharp pain in renal region followed by sudden or gradual swelling or mass in same area, accompanied by chills fever nausea vomiting, and frequently shock or collapse. Signs of collapse may be present in the traumatic type of rupture but absent in the spontaneous.

7 The clinical impression of ruptured pelvis should always be confirmed or substantiated by a thorough urological study including pyelography since this is the only dependable method of diagnosis. The advantages of the gravity method of pyelography and Wesson's combined method of intravenous urography and ureteral catheterization and the dangers of syringe pressure pyelography cannot be too strongly emphasized. In the extremely toxic and debilitated patients, retrograde pyelography is contra indicated but intravenous pyelography can be substituted without fear of producing any unpleasant symptoms or complications.

8 Successful treatment in cases of ruptured pelvis is directly dependent upon an early diagnosis and immediate surgical intervention. The ultimate choice of the operative procedure can only be made at time of operation and must take in consideration the general condition of the patient, pathological condition of the kidney as seen at operation, and the extent of the extravasation of urine or the suppurative process in the perirenal space.

9. Treatment may either be conservative or radical. The conservative procedure is essentially incision and drainage and if possible, correction of pathological processes responsible for the rupture and repair of the pelvic laceration. The radical procedure is nephrectomy provided the opposite kidney is healthy. In the very toxic and debilitated patients treatment should be carried out in two stages, viz., preliminary incision and drainage followed by nephrectomy or conservative repair at a later date.

BIBLIOGRAPHY¹

I Traumatic rupture of the kidney pelvis—31 cases

- 1 HAWKINS, C. Case of aqueous encysted tumor of the kidney. *Med. Chir. Tr.*, 1833, 18, 175—one case.

¹The cases in the first five groups are arranged in chronological order.

- 2 STANLEY, E. An account of two cases of rupture of the ureter or pelvis of the kidney from external violence followed by large effusion of urine into the abdomen. *Med. Chir. Tr. Lond.*, 1844, 27, 1—one case.
- 3 CROFT, J. A case of traumatic hydronephrosis. *Tr. Clin. Soc. Lond.* 1881, 14, 107—one case.
- 4 MAY, B. Injury to the kidney and obstruction to ureter: retention of urine in loam. *Brit. M. J.*, 1883, 1, 108—one case.
- 5 MORRIS, H. On the symptoms and treatment of contusions of the kidney. *Clin. J. Lond.* 1884, 4, 217—one case.
- 6 JACKSON, A. Case of subcutaneous rupture of the kidney. *Centraltbl. f. Chir.*, 1891, 18, 431—one case.
- 7 SNOW, H. Quoted by Kapel—one case.
- 8 DONOR, G. E. Subcutaneous rupture of the kidney with a report of nine cases. *Ann. Surg.* 1903, 36, 899-909—one case.
- 9 ROWLAND, R. P. Case of ruptured ureter due to trivial injury. *Med. Press. Circ. Lond.* 1909, 87, 404—one case.
- 10 WILDBOLT, H. Traumatische Hydronephrose geschieht durch Pyloneostomie. *Ztschr. f. Urol.* 1911, 5, 673-677—one case.
- 11 MARTIN, W. Rupture of the ureter followed by extravasation of urine and suppurative nephritis. *Nephrectomy*. *Ann. Surg.* 1912, 55, 468—one case.
- 12 BREZANCO, A. Two cases of ruptured hydronephrosis. *Ztschr. f. Urol.* 1912, 6, 713—two cases.
- 13 BAILEY, H. Injuries to the kidney and ureter. *Brit. J. Surg.*, 1923, 11, 600—four cases.
- 14 McALPIN, J. B. Traumatic rupture of a hydronephrosis. *Lancet*, 1923, 2, 833—one case.
- 15 NASH, W. G. Traumatic laceration of a hydronephrosis. *Lancet*, 1924, 1, 128—one case.
- 16 WESSON, M. B. The treatment of traumatic rupture of the kidney. *Ann. Surg.*, 1926, 83, 246—two cases.
- 17 LEGOUX, F. Quoted by Rosenkrantz in the discussion of Mathé's article—one case.
- 18 COWDEN, C. N. Surgical accident (Avulsion of ureter during removal of renal calculus). *Tr. South. Surg. Ass.* 1928, 41, 344—one case.
- 19 BEACH, E. W. Traumatic rupture of the kidney: report of ten cases. *Calif. & West. Med.* 1930, 30, 494—one case. Also reported by Wesson in 1926.
- 20 OSGOOD, A. T. and CAMPBELL, M. F. Injuries of the kidney. *Practice of Surgery*, edited by Dean Lewis. *Urology*, vol. 8, chap. 5. Hagerstown, Md. W. F. Prior Co., 1928-1930—two cases.
- 21 SCHMIDT, A. Spontaneous rupture of infected cystic kidney. *Ztschr. f. Urol.* 1931, 25, 93—one case.
- 22 MATHE, C. P. Spontaneous rupture of kidney. *Tr. Western Branch Soc. Am. Urol. Ass.* 1932, 1, 78. *Urol. & Cutan. Rev.* 1932, 36, 605—one case (Case IV).
- 23 LAZARUS, J. A. Traumatic rupture of a congenital hydronephrotic kidney. *Ann. Surg.* 1932, 95, 117—one case.
- 24 EWE, G. H. Traumatic rupture of a hydronephrotic kidney. *J. Urol.* 1933, 29, 685—one case.

II Spontaneous rupture of the kidney pelvis—26 cases

- 1 LEGOUX, F. Pyélographie d'une perforation de l'uretère par un calcul lombaire à pointe acérée. *Bull. Soc. franc. d'Urol.*, 1926, 5, 314—one case.
- 2 FUMERY, J. Péritonites d'origine rénale non traumatique, non postopératoire. (Louis Arnette) quoted by Kapel—one case.
- 3 MATHE, C. P., and OVIDIO, G. F. Spontaneous rupture of hydronephrotic sac secondary to ureteral stone. *Calif. & West. Med.* 1927, 26, 790—one case.

4. FETZ, W. Spontaneous and traumatic ruptures of the pelvis, four cases. *Wien Klin. Wchnsch.* 1928, 41: 1906—two cases.
 5. WALLSTEIN, S. Urinary extravasation at varying levels: a report of 16 cases. *Med. J. & Rec.* 1918, 315—one case.
 6. TUDOR, A. C. Unusual case of urinary fistula. *Lancet*, 1929, 2: 280—one case.
 7. GOTTSTEIN, Perforation paraprothetischer Abcesse in die freie Bauchhöhle. *Zentralbl. f. Chir.*, 1930, 56: 2436. Peritonitis of renal origin. *Ibid.*, 1930, 57: 1870—one case.
 8. BRACE, E. W. Loc. cit. ref. 19, Group I—one case.
 9. OSOONO, A. T. and CAMPBELL, M. F. Loc. cit. ref. 30, Group I—one case.
 10. BROWN, R. Spontaneous rupture of the renal pelvis. *Surg. Clin. N. America*, 1930, 10: 960—one case.
 11. GERSHBERG, F. J. Extravasation from ureter. *Ann. Surg.*, 1931, 93: 544—one case.
 12. ROSE, P. Perforation into abdominal cavity of pus from a calculous kidney case. *Zschr. f. Urol.* 1911, 25: 439—one case.
 13. NAMIKAWA, Rare operative findings in the field of kidney surgery. *Zentralbl. f. Chir.* 1931, 58: 2899—two cases.
 14. CRANE, J. J. Extravasation of urine from the ureter, secondary to ureteral calculi. *Western Urological Soc. San Francisco, California*, 1931: also personal communication—one case.
 5. MATHE, C. P. Loc. cit. ref. 22, Group I—three cases (Cases Nos. I, II, V).
 16. WHEATON, M. B. Rupture of ureter: a medico-legal problem: report of cases. *Calif. & West Med.* 1932, 37: 207—one case.
 17. HANCKEL, H. Free perforation of pyonephrosis into the abdominal cavity. *Deutsche Zschr. f. Chir.* 1912, 230: 35—one case.
 8. KAPPEL, O. Peritonitis of renal origin. *Deutsche Zschr. f. Chir.* 1932, 230: 467—two cases.
 9. AMAROUK, B. S. Three cases reported herein.
- III. Perforation of the pelvis by external instruments—3 cases
- HUNTER, G. L. Morbidity and surgical procedures following accidents incident to cystoscopic treatment of the ureter. *Practices of Surgery*, edited by Dean Lewis. *Urology* Vol. 8, Chap. II, pp. 57-78. 1928-1930, Hagerstown, Md. W. P. Prior Co.—three cases (Cases Nos. V, VI, VII).
15. Rupture of pelvis following pyelography—4 cases
 - HOFFMAN, E. R. Dangers of pyelography. *Folia urol.* 1914, vol. 7. *Zschr. f. Urol.* 1914, 8: 508—one case.
 2. HUNTER, G. L. Loc. cit. ref. Group III—one case (Case N. X).
 3. OSOONO, A. T. and CAMPBELL, M. F. Loc. cit. ref. 30, Group I—one case.
 4. KIRKALL, L. Rupture complications of syringe pressure pyelograms. *Urol. & Gynec. Rev.* 1935, 37: 711—one case.
 1. *Fistula formation between the renal pelvis and other organs—12 cases*
 - A. Reno-bronchial fistula
 1. DE HAEN. *Rain. Med. Pat.* 773, 3: 230 quoted by Miers—one case.
 2. RATER, P. Traité des fistules du rein. pp. 269-293. Paris: J. Baillière, 1859. Quoted by Miers and Higgins and Hickox—one case.
 5. MATHE, C. P. Loc. cit. ref. 22, Group I. This case is the same as that reported as the series of spontaneous rupture of the pelvis—one case.
 - B. Reno-colic fistula
 1. DICKINSON, W. H. *Renal and Urinary Affections*. New York: William Wood & Company 1885—two cases.
 2. WATSON, F. S. and CONINGTON, J. F. Subperitoneal infarcts of the kidneys. *Diseases and Surgery of the Genito-Urinary System*. Vol. 1 pp. 91-123. Philadelphia: Lea and Febiger 1906: 1: 91-123—one case.
 3. FULLER, E. Discussion of paper by Christ, A. L. Two cases of vesico-intestinal fistula due to diverticula of the sigmoid. *Tr. Am. Ass. Genito-Urin. Surg.* 1911, 6: 96—one case.
 4. WHEATON, M. D. Loc. cit. ref. 16, Group I. This case is the same as that reported in the series of spontaneous ruptures of the pelvis—one case.
 5. HIGGINS, C. C. and HICKOX, H. F. Spontaneous renal and ureteral fistulae. *Arch. Surg.* 1933, 37: 817-120 cases.
 - C. Reno-duodenal fistula
 1. RATER, P. Loc. cit., ref. A, 2, Group V—one case.
 2. DAVIS, E. G. Duodeno-ureteral fistula of spontaneous origin. *J. Am. M. Ass.* 1918, 70: 376—one case.
- III. General references
1. AULAYE, M. P. Note sur la situation du rein chez le jeune enfant par rapport à la crête iliaque et à l'insertion du pectopneumone. *Bull. et mémoires de la Soc. Anat. de Par.* 1910, 83: 595.
 2. BABITZKI, P. Hydronephrosenruptur und Pseudo-hydronephrose. *Arch. f. klin. Chir.* 1919, 97: 993.
 3. BOSSUVER, L. Rupture of hydronephrotic kidney, operation. *Bol. soc. de chir. de Chile*. March-April 1928, 6: 2.
 4. BOSSUVER, Subcutane Nierenrupturen. ein Fall von Nephrotomie nach Nierenruptur. *Zentralbl. f. Chir.* 1893, 19: 721.
 5. DELBET, P. De la contusion rénale et de son traitement. *Ann. de mal. d'org. genito-urin.* 1901, 19: 699.
 6. GIBSON, C. L. Rupture of kidney in children. *New York State J. Med.* 19: 2: 375. *Am. J. Med. Sci.*, 1912, 163: 649.
 7. GRAUWITZ, Ueber Nierenverletzungen. *Arch. f. klin. Chir.* 1908, 83: 347.
 8. GUTENBERG, P. Beiträge zur Lehre von der Nierenverletzungen. *Arch. f. klin. Chir.* 1896, 31: 215.
 9. HARRISMAN, A. H. Rupture of a hydronephrotic kidney. *Urol. & Gynec. Rev.* 1910, 23: 260.
 10. HARRISMAN, G. W. Discussion of Kindell's article.
 1. HARTLEY, R. B. Spontaneous rupture of kidney. *J. Am. M. Ass.* 1924, 83: 1411.
 12. HERRMAN, L. A case of ruptured hydronephrosis. *J. Urol.* 1927, 18: 458.
 13. HUNTER, G. L. Discussion of Kindell's article.
 14. KOWTZ, E. Zur Entstehung der subcutanen Nierenverletzungen und der Wandernieren. *Arch. f. klin. Chir.* 1893, 2: 676-686.
 15. Idem. Verletzungen der Nieren. *Die chirurgischen Krankheiten der Nieren. Deutsche Chirurgie*. By v. Bergmann and P. V. Braun, 1913: 721-736. Stuttgart, Enke, 1896-1902.
 16. LE DENTU, A. Affections chirurgicales des reins, des uretères et des capsules surrénales. pp. 1-91. Paris: G. Masson, 1889.

- 17 LÉGOUX F. De l'hydronéphrose traumatique. *Bull Med. Par.* 1909, 23 389
- 18 LUCKETT and FRIEDMAN. Pyelography in the diagnosis of traumatic injury of the kidney. *Ann Surg.* 1914, 60 729
- 19 MICKITZ, H. O. Spontaneous renocolic fistula with report of two cases of renocolic fistula. *Tr Am Ass Genito-Urin Surg.* 1931 24 115
- 20 MORRIS, H. Injuries of the Ureter. On the Origin and Progress of Renal Surgery. pp 127-155. Philadelphia. P. Blakiston's Son & Co. 1898. Edinburgh M. J. 1898 3 11
- 21 Idem. Injuries of the Kidney. *Surgical Diseases of the Kidney and Ureter*. Vol 1. pp 141-198. London. Cassell and Co. 1908
- 22 SCHENK, M. Injuries of the Kidney. By v. Bergmann and Bull. Vol 5 pp 229-241. *System of Practical Surgery*. Philadelphia. Lea Bros and Co. 1904
- 23 TUFFIER, T. Traumatismes du rein. In *Traité de Chirurgie*. S. Dehay P. Reclus G. Masson 1892 7 476-493
- 24 VERMOOTEN V. and McKEOWN R. M. Renocolic fistula. *Am. J. Surg.* 1933 21 242.
- 25 WALKER, R. M. Spontaneous rupture of hydronephrosis. *Brit. J. Urol.* 1933, 5 139
- 26 WALTERS, W. Resection of the renal pelvis for hydronephrosis its complications and results. *Surg. Gynec. & Obst.* 1930 51 711
- 27 Idem. Resections of the renal pelvis for hydronephrosis. *Surg. Gynec. & Obst.* 1932 55 508

FRACTURES OF THE HUMERUS END-RESULTS FROM TREATMENT

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THE following review of end-results from treatment of fractures of the humerus covers a 5 year period from January 1 1936 to December 31 1940. All cases of fracture of the humerus encountered at the Mayo Clinic during this period are reviewed here. For the purpose of tabulation we have divided these cases into 8 groups.

Our classification does not conform to the one usually given. In most classifications supracondylar fractures are all grouped with "fractures of the elbow" and in many of such classifications the elbow and head of the humerus are fractures of the neck and head of the shoulder. We have grouped with fractures of the shoulder fractures with fractures of the supracondylar fractures not attempted to divide supracondylar fractures into the usual groups but have separated fractures of the single condyles, epicondyles, and the capitulum as well as those of the trochlea. This grouping conforms to anatomical types and presents interesting comparative features, particularly in regard to the incidence of late nerve complications associated with injuries about the elbow.

The predominance of old fractures of the shaft will be seen in Table I. This, of course, is a fracture that is seen frequently but at the same time it must be realized that it is a difficult fracture to treat and one that leads to many unsatisfactory results. This predominance is partly accounted for by the frequent injury of the musculospiral nerve, a complication that in many cases leads to a major complaint, and the frequency with which non-union is also encountered combined with injury of the musculospiral nerve to make up the majority of cases in this group of old fractures of the humerus.

In Table II we have listed the cases of old fracture of the shaft of the humerus according to the main complaint on admission, that is, the chief reason why patients sought further medical advice and treatment. Non-union makes up the largest of these groups, and because of the frequency with which it is encountered in fractures of the humerus it would be expected to be the most frequent complaint. Taking the cases of non-union alone, and adding to them the cases of non-union with nerve injury and non-union with

infection, we have a total of 55 cases, or about 65 per cent of the entire group. This group contains a few cases that should be classed as delayed union. We have considered all cases that were seen more than 2 weeks after the time of injury as old fractures. There are, therefore, a few cases that should be classed not as delayed union or non-union but simply as cases of recent fracture with malposition.

Some few patients were given reassurance that their arms would be all right, and this satisfied them. There were 2 pathological fractures in the group one resulting from a bone cyst and the other almost certainly from parathyroid hyperfunction with osteitis fibrosa cystica. One case was a medical problem only the patient coming with her lawyer rather than with her physician.

This group of cases represents, of course, a great many failures of treatment elsewhere. From the study it is hard to account for all of these failures many perhaps, were due to poor reduction, some, to infection and so forth. It seems to us, however, that probably the most common cause of failure was too short a period of fixation or inadequate fixation. The humerus is probably the most difficult bone in the body to fix adequately and securely and it is apparent from the study that this is a common cause of failure in its treatment.

Besides the original surgical treatment in the cases set forth in Table III in many cases there had been operations for non-union. In all, 44 patients had had surgical operations prior to their admission to the clinic. Several of these patients had had multiple operations performed as many as 4 in some instances. In all, 78 operations had been performed in these 44 cases, or an average of 1.8 operations per patient.

The problem presented in these cases, therefore, varied considerably. The non-union group presented the most important problem from the standpoint of the orthopedic surgeon.

In the majority of cases listed in Table II treatment consisted of massive bone graft, as described by Henderson. Very little modification in this technique has taken place since that time.

TABLE I—FRACTURES OF HUMERUS 1926-1930
INCLUSIVE

	Cases
Shaft old	89
Shaft new	33
Neck and head old	30
Neck and head new	37
Serratuscostalis old	35
Serratuscostalis new	30
Coracoclavicular and coracoclavicular old	23
Coracoclavicular and coracoclavicular new	22
Total	341

TABLE II—FRACTURES OF HUMERUS SHAFT
OLD

	Cases
On anastomosis	38
Non-union alone	10
Non-union with nerve injury	5
Nerve injury	0
Non-union and infection	0
For reamance	2
Infection	0
Pathological fracture	2
Limited joint motion	1
Medioclavicular case	1
Nerve injury and infection	1
Total	89

In several instances, where sequestra were present or where there was any sort of infection it was necessary to do one or two preliminary operations to prepare the bone for the graft. The removal of foreign fixative substances, such as bone plates or Parham bands may be done at the same time that the bone graft is applied, provided no infection is present. When infection is present, it should be cleared up and should be quiescent for a period of 6 months to 2 years before a bone graft operation is undertaken.

Care must be exercised to get the ends of the ununited bone to fit together as accurately as possible. One must also drill the eburnated ends so that a sufficient opening is made into the marrow cavity to allow new circulation to be established through the eburnated bone. The graft is fitted as accurately as possible to the surface of the bone and held with a clamp until beef bone screws can be inserted to hold it in place. A plaster-of-paris body-cast with the arm in 45 degrees abduction is applied. Much operative time can be saved by applying the body portion of the cast prior to operation.

At the end of 3 weeks the wound should be dressed and the sutures removed. The period of fixation with the plaster after this varies considerably. In most instances union will be firm enough at the end of 3 months to allow removal of the cast and the use of a sling. However, one must be guided by examination of the part, both by roentgenogram and by physical examination. Too long a fixation period is far better than one that is too short. In a few cases it may be safe

TABLE III—FRACTURES OF HUMERUS SHAFT
OLD

Original treatment (elsewhere)	Cases
Closed	36
Open	33
Large plate	18
Parham band	2
Wire	4
Nerve suture and repair	3
Beef bone peg	2
Beef bone plate	1
Kangaroo tendon	1
Bone removed	1
Metal screw	1
Open reduction	1
Total	89

TABLE IV—FRACTURES OF HUMERUS SHAFT
OLD (89 CASES)—BONE TRANSPLANTS

	Cases treated at clinic	Results		
		Good	Fair	Poor
Massive bone transplants	10	16	1	9
Removal of foreign body or sequestra and bone transplant	10	9	1	
Sequestrectomy and bone graft	4	3	1	
Osteoperiosteal graft with bone screws	3	3		
Intra-medullary and onlay graft				
Total	27	3	3	3

to change from a plaster-of-paris cast to an aeroplane splint at the end of 8 weeks. However as a rule it is much safer to continue with the plaster cast until the end of 3 months at least. Rehabilitation should be carried out only after one is certain that union has taken place. Massage and active exercises should be the modes of re-establishing movement of the affected part.

In cases where infection was the predominating cause of complaint treatment was carried out according to the stage of the infection, and when sequestra were present they were removed surgically. In general a modified Orr treatment was used for osteomyelitis (Table V) that is thorough surgical preparation of the wound, using vaseline gauze packs as dressings. These were usually changed once a week to prevent the odor from becoming too offensive.

The cases summarized in Table VI present nerve complications as the most important physical finding and make up a large group they will be dealt with more fully in another paper. This table is inserted here to complete this statistical study.

As we have stated before all fractures under 2 weeks duration have been considered new fractures. In the group in Table VII there were 35 of these fractures over the 5 year period, and the

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TABLE V.—FRACTURES OF HUMERUS SHAFT
OLD (89 CASES)—MISCELLANEOUS TYPES

	Cases treated at clinic	Results			
		Good	Fair	Poor	Un- known
Sequestrectomy	7	3			
Splint	4				
Physiotherapy	4				1
Open reduction with bone screws	5				
Removal of foreign body or sequestra	3				
Pathological, no treatment					
Beef bone plate					
Cast					
Total	25	9		7	7

No antiseptic treatment given in 27 cases. Refused, advice only (neurological cases included)

TABLE VI.—FRACTURES OF HUMERUS SHAFT
OLD (89 CASES) COMPLICATING NERVE LESIONS*

	Cases treated at clinic	Results			
		Complete recovery	Partial recovery	No recovery	Un- known
Non surgical treatment	9	6		3	1
Surgical treatment					
Explored, no suture					
Explored, neurolysis	4		3		
Explored, sutured	5			4	
Proximal pleural laceration	5				
Median nerve					
Ulnar nerve, sutured					
Total	7			6	8

*Macleod and primary cases, secondary 8 cases

way these were treated and the results obtained are indicated in the table.

In the consideration of the treatment of acute fracture of the shaft of the humerus, several facts are of importance in coming to a conclusion as to the type of treatment best suited to the case. Simple transverse fractures are best held by some

We have used the terms good, fair, poor and unknown. As good results, were classed all those cases in which firm bony union without deformity and with practically no limitation of motion were obtained. Under fair results were classed the cases in which firm bony union followed but with some deformity or limitation of motion. Under poor results were classed the cases in which union was not obtained or in which there was some impairment of function or deformity sufficient to make the patient seriously handicapped by the result. Unknown results were classed the cases in which the patient was unable to give results. It should be noted also that in many cases where no treatment was recommended, particularly in the case of old fractures without any prospect of improvement, no follow-up was attempted.

TABLE VII.—FRACTURES OF HUMERUS SHAFT
NEW (35 CASES)

	Cases treated at clinic	Results		
		Good	Fair	Un- known
Open (cases)				
No internal fixation	4			
Beef bone plate	3	3		
Beef bone screw				
Beef bone screw and Parham band				
Lane plate	1			
Closed (34 cases)				
Cast	8	6		
Acroplane splint	7	6		
Velpeau bandage	4	3		
Not treated	2			
Red traction				
Beef bone				
Total	34	16		5

*Two died.

form of internal fixation, either a bone plate or a beef bone screw. In many cases it is extremely difficult to get enough engagement of the fragments without internal fixation to hold the fracture either in a cast or in an acroplane splint. Oblique or spiral fractures are more easily held in most instances, but excellent position may be obtained by the use of some form of internal fixation, either a beef bone screw or a Parham band.

As will be seen in the table in most cases treatment consisted of either a cast or an acroplane splint with traction. Often when a cast was used, some type of traction was also used making a fixed traction type of support. When traction is used it should always be checked carefully with the roentgenogram to prevent the fragments from being pulled apart. Comminuted fractures of the humerus must always be considered most favorable for such treatment because of the difficulty in getting sufficient fixation by any form of internal fixation.

In the 2 cases in which the patients died, there were severe multiple injuries, and fractures of the humeri were merely incidental to the cause of death. Fractures treated with Velpeau bandages were green stick fractures without enough separation to require any additional fixation. "Red traction" is shown as having been used in only 1 case. As a matter of fact, it was used in a considerable number of cases preliminary to casts or

TABLE VIII.—FRACTURES OF HUMERUS NECK AND HEAD OLD (39 CASES)*

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Neck and head (31 cases)					
Physiotherapy	11	6	2		3
Aeroplane splint	2				2
Open, beef bone screw	4	3	1		
Excision head	2		2		
Removal wire	2				1
Manipulated	1	1			
Greater tuberosity (6 cases)					
Physiotherapy	2				2
Manipulation	2	1		1	
Aeroplane splint	1				1
No treatment	1				1
Epiphyseal separation					
Open, beef bone screw	1	1			
Osteomyelitis					
Ectostriectomy	1				1
Total	31	11	3	1	13

* 8 cases had no treatment

TABLE IX.—FRACTURES OF HUMERUS NECK AND HEAD NEW (57 CASES) (SURGICAL NECK 38 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Surgical neck, simple (21 cases)					
Aeroplane splint	14	8	2	1	3
Open, beef bone screw	5	4	1		3
Open, no fixation	2	1	1		
Cast	3	2	1		
Bandage	1			1	
Surgical neck, comminuted (4 cases)					
Aeroplane splint	3		1		1
Open, no fixation	1	1			
Surgical neck, comminuted with dislocation of head (4 cases)					
Aeroplane splint	2	1			1
Open, no fixation	2	1		1	
Surgical neck, impacted (1 case)					
Aeroplane splint	2	2			
Total	38	20	6	3	9

to aeroplane splints in the more severe injuries it is a necessity. In fractures of the humerus with some over riding or deformity, bed traction will be found very useful in reducing the deformity and improving the position. In cases of severe swelling in which rest is needed it is a practical method of obtaining correction of the position and absolute rest in bed at the same time.

One case of fracture of both humeri is listed. These are difficult cases in which to secure proper fixation. The use of the aeroplane splint is difficult and oftentimes impossible. A double cast is the most satisfactory fixation, provided one gets accurate replacement. We feel that in these cases, where conditions permit, internal fixation of at least one bone will give the best results. Bed traction cannot be continued in these cases for over a few days at a time.

In many ways the cases listed in Table VIII are the most difficult types in which to obtain satisfactory results. Old stiff shoulders especially those with dislocation or deformity, offer about as unfruitful a field for obtaining successful results as anyone can imagine. However, in many instances marked improvement can be obtained with persistent and skillfully applied physiotherapy, particularly with active and passive

movements. Fractures treated by open reduction with beef bone screws were comparatively recent ones in which reduction could be accomplished. The 2 cases in which excision of the humeral head was done were old fractures of the neck with dislocation of the head. These are without doubt the most unsatisfactory cases of all for successful treatment. Excision of the head of the humerus does not give a good result. It does, as a rule, however relieve pain, and it may relieve pressure on the nerves in the axilla, thus preventing or minimizing the secondary nerve changes that often take place.

A group of 6 cases of fracture of the greater tuberosity are included in this table. Unless marked displacement takes place in these fractures, no special attempt at reduction is necessary. Some advocate abduction of the arm by the use of an aeroplane splint to prevent displacement of the fragments by the pull of the supraspinatus and infraspinatus tendons. Unfortunately, in this particular group we were able to follow only 2 cases in both of which there had been attempts to improve the movement in the shoulder by manipulation. This is a procedure of value in some cases, but we must emphasize the fact that

TABLE X.—FRACTURES OF HUMERUS NECK AND HEAD NEW (57 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Anatomical neck (13 cases)					
Acroplane splint	4	3			
Open, no fixation	3				
Open, beef bone screw					
Bandage	4				
Greater tuberosity (4 cases)					
Acroplane splint					
Open, beef bone screw					
Cast (dislocation)					
Slings					
Lesser tuberosity					
Slings					
Pathological (giant-cell tumor)					
Carpectomy and bone graft					
Total	9		3		3

it must be used with a great deal of care in the treatment of old fractures, because of the danger of pathological fracture when atrophy through disuse is marked.

In the group in Table IX, we again return to the more acute fractures, and we have tabulated the fractures of the surgical neck. As will be seen in this table, the most frequently used type of treatment was the acroplane splint. In these cases a splint without traction should be used. It should be carefully fixed with adequate support to hold it up into the axilla. At the clinic, we make each splint to fit the individual patient. When much malposition or displacement is present, manipulation under anesthesia is the routine before application of the splint. Where satisfactory reposition of the fragment cannot be obtained, we feel that open operation is indicated and the most useful form of internal fixation has been the beef bone screw. In some cases no internal fixation is necessary. Good alignment can thus be obtained and the results have well justified the means. No poor results were obtained in any of the fractures treated by open reduction. In estimating these results we have only listed as good results those with union without deformity and with practically a normal range of motion. Those with fair results included the cases in which union was obtained but in which normal motion

TABLE XI.—FRACTURES OF HUMERUS (SUPRA CONDYLAR) OLD (38 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Deformity (1 case)					
Physiotherapy	6				1
No treatment					
Open reduction					
Arctural operation (not done)					
Arthroplasty					
Transplant ulnar nerve					
Amputated section (4 cases)					
Arthroplasty	3				
Physiotherapy	3				
No treatment	6				4
Capitotomy					
Manipulation					
United malunion and infection					
Drainage					
Myositis ossificans		no treatment			
Osteosarcoma distal humerus					
Removal of loose bodies					
Total	30	7	3		7

was not recovered, although in most of these there was sufficient motion to allow use of the shoulder.

It will be noted in Table X that in these cases open reduction did not produce as good results as in fracture of the surgical neck. Usually fracture of the anatomical neck presents a much more difficult problem because of the small size of the proximal fragment. When severe displacement occurs, however, it is often impossible to obtain satisfactory reduction by manipulation and open methods must be resorted to. These types are usually more serious and are doomed to a very unsatisfactory result if left alone.

Strangely enough the 4 fractures of the greater tuberosity were each treated in a different manner. All the results were satisfactory where final reports were available, which goes to show that any method of treatment that is carried out carefully may produce good results in this type of fracture.

One fracture of the lesser tuberosity and one pathological fracture in a case of giant cell tumor of the head of the humerus are included in the list and need no comment.

TABLE VII—FRACTURES OF HUMERUS (SUPRA CONDYLAR) OLD (38 CASES)

	Cases treated at clinic	Results		
		Fair	Poor	Unknown
Volkmann's ischaemic paralysis (8 cases)				
Splint and physiotherapy	4	3	1	1
Tendon plastic	1			
Osteotomy	3		1	
No treatment				1
Total	8	4	2	

The group of cases in Table VI represents a type of fracture in many ways as difficult to treat as old fractures of the head and neck of the humerus. In fact, this type may be regarded as worse because it is with these fractures that Volkmann's ischaemic paralysis occurs and in many of the cases there are complicating injuries of the ulnar nerve in addition. No special form of treatment seems to be applicable, and each case is a problem in itself.

We have divided the cases according to those in which the chief complaint was of deformity and those in which it was of limited motion. Arthroplasty in these cases does not offer a great deal, if we are to judge by the results obtained in this group. It should not be entirely condemned, however, as we have seen occasional good results from its use. Attempts to correct the deformity except in fairly recent cases usually meet with unsatisfactory results. Again, skillfully handled physiotherapy is the most useful method of treatment. We do not feel that manipulation in these cases offers much. We have occasionally seen cases where numerous manipulations have been carried on over a period of several weeks, convalescence. Usually the results are not good.

The group of cases of Volkmann's paralysis presented in Table VII is fairly representative of results in such cases. In 2 cases in which treatment consisted of Jones' ischaemic paralysis splints and physiotherapy there was some improvement. In 2 cases in which tendon plastic operations were done there were fair results. The degree of success in these cases is inversely proportional to the severity of the deformity and paralysis.

The end-results in this group of new supra condylar fractures (Table VIII) emphasize the fact that adequate early treatment may prevent many poor results. We have 3 essential things to consider in this group (1) the reduction of the

TABLE VIII—FRACTURES OF HUMERUS (SUPRA CONDYLAR) NEW (38 CASES)*

	Cases treated at clinic	Results		
		Good	Fair	Unknown
With displacement (30 cases)				
Manipulation, acute flexion	17	14	2	1
Open, beef bone screw	5	1	3	
Open, output fixation	7	3	3	1
Without displacement (4 cases)				
Cast	2	2		
Skull	1	1		
Acute flexion	1	1		
Total	35	22	8	5

3 cases not treated here.

fracture, which is of the utmost importance and should be accomplished in as short a time as possible (2) the hæmorrhage that may take place, causing a swelling which must always be considered a potential source of trouble, particularly because of the possibility of development of Volkmann's ischaemic paralysis and (3) the type of fixation, which must not be constricting enough to cause any further impairment of circulation and must not cause compression of the musculospiral nerve.

The need for adequate early reduction and proper fixation is recognized by all. When there is marked swelling, however, as a rule something must be done to relieve it. Elevation of the arm may be used but it is a slow method and for this reason, somewhat dangerous. We have aspirated hæmatomata of large size as a means of reducing the swelling. The other alternative is open reduction, which of course evacuates the blood clot and relieves tension so that much of the danger of ischaemia is averted. In difficult cases with marked swelling we feel that it is the choice method of treatment, provided facilities are at hand for carrying out careful bone surgery.

The choice position of fixation in these cases is acute flexion although such a position is not without danger, as has already been indicated. If swelling is great flexion to an acute angle may further embarrass the circulation. A position must be employed in which the radial pulse can be felt. Furthermore, any type of constricting dressing must either be watched carefully or else not used. If adhesive strips are used to hold the angle of fixation they must be placed so as to avoid pressure on the musculospiral nerve. In

TABLE XIV—FRACTURES OF CONDYLE AND CAPITELLUM NEW (22 CASES)

	Cases treated at clinic	Results		
		Good	Fair	Unknown
Capitellum (8 cases)				
Open, removal fragment				
Open, beef bone screw				
Open, fragments sutured				
Slung				
Radial condyle (8 cases)				
Acute flexion		3		
Open, suture		1		
Slung				
Physiotherapy				
Ulnar condyle (5 cases)				
Excision				
Slung				
Ulnar epicondyle (4 cases)				
Acute flexion		2		
Open, beef bone screws				
Slung				
Radial epicondyle (1 case)				
Acute flexion				
Total		5		

many cases a moulded, posterior plaster-of-paris splint is the safest sort of dressing.

Early motion is desirable. But, unless early motion can be supervised by the surgeon himself or by an expert physiotherapist, disappointing results may ensue. In children under proper conditions motion may be begun at the end of 1 week, provided perfect reduction has been accomplished. However it is safer to wait from 10 days to 2 weeks before starting such movement in most cases.

One must not be distressed at slow recovery of movement. Children are often very slow to push their activities to the point of pain. Patience and time will, in most instances, produce excellent results. Impatience, resulting in manipulations under anesthesia, may produce a persistently painful elbow without any improvement in motion.

This group of fractures (Table XIV) has been classed separately because, for the most part, they make up an entirely distinct group. By distinct is meant that they should be distinguished from the usual supracondylar fracture. We found in

TABLE XV—FRACTURES OF CONDYLE AND CAPITELLUM OLD (22 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Radial condyle (11 cases)					
No treatment	4				3
Physiotherapy	4				
Ulnar nerve transplant					
Advised nerve transplant					
Removal of wire					
Ulnar condyle (3 cases)					
No treatment	3				3
Physiotherapy					
Ulnar nerve transplant					1
Volarisimus paralysis (trismus plantae)					
Radial epicondyle (1 case)					
Ulnar nerve transplant					
Ulnar epicondyle (1 case)					
No treatment					
Capitellum (1 case)					
Advised operation (refused)					
Total	22	3	4	3	12

reviewing our cases that in many the diagnosis was not accurate when filed, and only by reviewing the roentgenograms were we able to make the correct diagnosis. Fractures of one or the other condyle are almost certain to lead to trouble if not accurately reduced. Two complications must be looked for: (1) an almost certain bony deformity, either cubitus valgus or varus, depending on whether the internal or the external condyle is displaced, (2) tardy ulnar palsy. Of 8 cases of late paralysis of the ulnar nerve, in 4 there were fractures of the radial condyle, in 3 of the ulnar condyle, and in 1 the diagnosis was intercondylar fracture. Accurate replacement of these fragments, then, is of the utmost importance, and in case of inability to get them back into position by closed reduction one should not hesitate to perform open reduction. When no displacement is present, and this is often the case, the problem is simply one of proper fixation. When severe comminution of either condyle or capitellum takes place, the best treatment is removal of the bone fragments.

The group of old cases in Table XV presents an unsatisfactory group from the standpoint of treatment. The reasons are obvious. Severe de-

formities caused by upward displacement of one or the other condyle are very unsuccessfully treated by surgery.

Transplants of the ulnar nerve in these cases will be reviewed in another paper. The fact that among the 22 cases either no treatment or physiotherapy was advised in 14 shows how little could be offered from the standpoint of reconstructive surgery.

SUMMARY

We have reviewed 341 cases of fracture of the humerus seen over a 5 year period at the Mayo

Clinic. These comprise all types, new and old, and are grouped according to anatomical type. Each group is discussed briefly. The old fractures of the shaft offer the most interesting group from the standpoint of bone surgery. Out of 37 such cases, good results were obtained in 84 per cent and poor results in 8 per cent.

REFERENCES

1. HENDERSON, M. S. Non-union of the humerus, etc. *South. M. J.* 1921 14: 148-153.
2. Idem. Non-union in fractures the massive bone graft. *J. Am. M. Ass.* 1923 81: 463-468.

ACUTE MECHANICAL INTESTINAL OBSTRUCTION MORTALITY WITH AND WITHOUT ENTEROSTOMIES

BASED ON A REVIEW OF 241 CASES FROM THE RECORDS OF THE COOK COUNTY HOSPITAL
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DURING the past 15 years the literature has been filled with accounts of the value of enterostomies advising their performance when in the least doubt of an obstruction and claiming marvelous results. These claims have not been made with any qualifying statement that the quoted results can be obtained in certain skillful hands, but have been broadcast in such a manner as to lead one to believe that any individual can make an enterostomy in any particular portion of the small bowel with little or no danger to the patient, and with a great certainty as to the ultimate favorable outcome. In other words, that enterostomy is a definite and distinct life saving procedure. Its advocates have apparently forgotten the struggles of Nicholas Senn, Jacob Frank, John B. Murphy and others, to overcome the great morbidity associated with enterostomy, a procedure which had been in use for several centuries, by perfecting a means of end-to-end or lateral anastomosis.

Many writers recommend the making of enterostomies, but do not mention any attempt whatever to relieve the obstruction. The accompanying case histories from Cook County Hospital, which have been studied with great care, show the mortality of an acute intestinal obstruction in relation to enterostomies of any kind, as well as the mortality of resections. They also show the great value of an early exploratory operation when there is any doubt concerning an acute intestinal obstruction whether it be complete or incomplete.

The mass of experimental work that has been done upon intestinal obstruction has so many different angles that it would be impossible to attempt to discuss adequately every phase of that problem in this article. We can, however, say with certainty that most of it has been fruitless and serves only to confuse us in our efforts to lessen mortality unless an early operation is performed and if possible the obstruction is also removed.

We have reviewed 241 cases from the records of the Cook County Hospital. From this mass of material we have attempted to extract a few facts that will be helpful in handling this serious surgical emergency without attempting to discuss

every controversial point which would lead us away from clinical cases to an involved discussion of the theories and experimental work.

The case records reviewed cover all cases filed under the head of "Acute Mechanical Intestinal Obstruction" during the years from 1922 to 1931. This does not include strangulated external hernias or chronic obstructions, which are filed separately and which present a somewhat different problem. For the purposes of statistical study only those cases operated upon are included. Cases of obstruction secondary to carcinoma or intra-abdominal abscess are not included because of complications peculiar to this type of case. A few of these cases were not completely obstructed, but all were of the acute type which constitutes a surgical emergency.

ETIOLOGY

For the sake of brevity we shall discuss under etiology only the type of case reviewed. A more complete discussion of the whole subject would properly include adynamic ileus, ileus due to peritonitis, mesenteric thrombosis, and cases mentioned in the preceding paragraph.

The relation of age and sex to the occurrence of acute mechanical intestinal obstruction is shown in Table I. The condition is quite evenly divided between the sexes. After the age of intussusception it decreases in childhood and is evenly distributed throughout adult life. Except that intussusception occurs in infancy usually below the age of 3 years is of little value in diagnosis.

Adhesions, forming bands or kinks, and foramina through which the bowel may herniate, are the most common causes of mechanical intestinal obstruction (Table I). They account for 74 per cent of the cases in this series. It is important to note that 34 or 39 per cent, of these cases due to adhesions had had no previous surgery. Cases due to postoperative adhesions were most common following surgical procedures for intra-abdominal infection. There were included in the pelvic operations, however, 15 hysterectomies which were not associated with known pelvic infection. The miscellaneous operations include gunshot wounds and various operations too infrequent to classify separately.

In the 34 cases due to adhesions not associated with previous surgery the cause was not determined in 23. In the 11 remaining cases in which the cause was determined the frequency and variety of inflammatory insults that are the common cause of adhesions are clearly demonstrated.

Intussusception is the next most common cause of mechanical obstruction, (21 in this series—8.7 per cent). The majority occur in infancy below the age of 2. In the 4 occurring in later years, 2 were due to benign tumors and in 2 no cause was found (Table I).

Internal hernias occurred in 5 per cent of the cases in this series. These are cases not produced by adhesions and the cause of these hernias can not be definitely stated. The most probable explanation is that they were of congenital origin (Table I).

Volvulus occurred in 3.7 per cent of the cases. Many of the cases of volvulus are really due to adhesions and where the etiologic factor seemed solely the result of adhesions, they were classified under that heading. True volvulus not associated with adhesions or previous operative procedures is rare and in this series constituted only 1.7 per cent of the cases (Table I).

Meckel's diverticulum causes obstruction due to either the formation of adhesions around an inflamed diverticulum or invagination and intussusception. As a cause of intestinal obstruction it occurs about as frequently as a true volvulus in this series of cases. Other rare causes are shown in Table I.

That acute mechanical obstruction can be produced by a variety of causes must be kept in mind when making a diagnosis. The fact that no known etiologic factor is apparent from the history and examination of the patient should not be confusing when the other symptoms and physical findings are present.

SYMPTOMATOLOGY

The cardinal symptoms of intestinal obstruction were pain, nausea, vomiting, and constipation.

Pain was usually the first symptom complained of. It was invariably present. Its character is of diagnostic importance. The early pain was probably due to increased peristalsis as the bowel struggled to force its contents past the obstruction. It was intermittent, occurring at intervals which varied somewhat with the type, completeness, and duration of the obstruction. Auscultation will show peristalsis in many cases to be most active at the height of the pain. This type of peristaltic pain is important diagnostically as it is

TABLE I—SEX AND AGE INCIDENCE AND ETIOLOGY

		Cases
I. Sex	Male	110
	Female	90
	Infants (sex not noted)	—
		241
II. Age	Infancy (under yrs)	14
	0 to 1 years	10
	11 to 20 years	25
	21 to 30 years	23
	31 to 40 years	9
	41 to 50 years	7
	51 to 60 years	90
	61 to 70 years	5
	71 to 80 years	5
	8 years	1
	Age not noted	18
		24
III. Etiology		
A. Adhesions		(74%) 170
Causes of adhesions		—
1. Previous surgery		57
a. Previous pelvic operations		66
b. Previously operated upon for appendicitis		40
c. Miscellaneous operations		3
2. No previous surgery		54
a. Cause not determined		23
b. Apparent cause determined		11
1. Old inflammatory changes in region of appendix		4
2. Old tubal disease		2
3. Adhesions to large mesenteric gland		2
4. Adhesions to ovarian cyst		2
5. Radiation treatment for cancer of cervix		1
6. Months before		1
6. Adhesions to ectopic pregnancy		1
7. Not noted whether previous surgery and cause not determined		8
B. Intussusception		21
1. In infancy		7
a. Due to benign tumors		2
b. Multiple polyps		1
c. Fibrosis		1
2. At the age of 12		1
3. Compounded chronic in adult		1
C. Internal hernia		5
Through hole in omentum		4
Through hole in mesentery		3
Dysplastic hernia		1
Femoral ring		1
Obturator foramen		1
Internal inguinal ring		1
Cause not known		1
D. Volvulus		9
1. Related to previous surgical procedures		5
2. No previous surgery		4
E. Meckel's diverticulum		4
With adhesions		3
Invagination with intussusception		1
F. Other congenital anomalies		2
1. Fetal mucous colitis		1
2. Congenital closure of ileum and large bowel		1
G. Foreign body		2
1. Type not ascertained, but probably gall stone		1
2. Gall stone		1
H. Trauma		1
1. Interposition of hepatic flexure between liver and diaphragm		1
I. Obstruction to pressure from mesenteric gland		1
J. Previously reduced strangulated hernia (with gangrene of bowel at operation)		1
K. Etiology not found		9

quite different from that due to peritoneal irritation. The location of the pain was most often in the region of the umbilicus, but did occur in other regions of the abdomen. However, it was not well localized and could not be used as an indication of the location of the obstruction. As distention

and prostration increased and peristalsis decreased, the pain became more generalized and in many cases was less severe.

Nausea and vomiting occurred at or a short time after the onset of the obstruction, the interval depending on the completeness and location of the obstruction. Vomiting increased in frequency as the obstruction became more severe. The character of the vomitus changed and became foul—slowly if obstruction was incomplete rapidly, if it was complete.

Obstipation was as constant as pain and vomiting, but often more confusing in its interpretation and determination. A patient may be constipated before the actual onset of obstruction or the obstruction be so fulminating that the lack of a bowel movement since onset is not abnormal. The determination of obstipation by the use of the enema is a subject about which there is some current controversy. In this series of cases enemas gave valuable information. The results of enemas as an aid in diagnosis may, however, be misleading unless interpreted properly.

Wangensteen has shown in dogs that a bowel may evacuate itself below a complete obstruction after an enema, and has observed the same phenomenon in clinical material. One of us operated for an obstruction 2 hours after gas and feces were obtained by an enema, and found a gangrenous bowel. We have also observed that a bowel may evacuate itself early due to the initial insult of a developing obstruction and thereafter very little if any gas will form distal to the obstruction. It must be remembered that it is probably impossible to tell the exact time when a partial obstruction becomes complete, and that there may be results from an enema in case of a partial obstruction that may rapidly progress to completeness. Enemas were given in 97 cases classified as nearly as possible by the operative findings as complete obstruction. In 86 cases, or 88 per cent, the enema was returned clear or slightly colored; usually poor results was the notation used in the chart. In 11 cases, or 13 per cent, good or fair results were obtained, but in only 2 of these cases was a second enema given which gave a return of feces and gas. In 7 cases classified under "poor or no results, the first enema gave a return of fecal material and gas and the second no results. Results of enemas given were noted in 17 cases classified as partial obstruction. Good results were noted in 10 cases, or 58.8 per cent, and poor results in 7 cases or 41.2 per cent. When the diagnosis is in doubt, a second enema should be given. The records of the enemas did not in every case indicate the results

completely and accurately. Much better information will be obtained if the surgeon is present when the enema is given, rather than relying on the observation of the nurse. It is evident from these statistics that the results of enemas must be properly interpreted if they are to be of value in making a diagnosis of mechanical obstruction. Peristalsis should be present, indicating that the bowel is attempting to empty itself and that diffuse peritonitis is absent. If feces and gas are obtained and the symptoms of distention, pain, and vomiting are not relieved, one may be certain that the obstruction continues and surgery is indicated. Results after an enema are not a contraindication to surgery unless the patient is relieved, and in many cases symptoms will recur requiring surgery. If feces and gas are obtained from the first enema, further enemas will usually be returned without gas or feces if the obstruction is complete or approaching completeness.

PHYSICAL FINDINGS

Intestinal obstruction was not associated with a constant rise in temperature in this series of cases. In those cases without gangrene, 44 per cent were from 97 degrees to 98.6 degrees; 27 per cent were elevated less than 1 degree; 25 per cent elevated from 1 to 2 degrees; and 3 per cent elevated over 2 degrees. Less than 1 per cent were under 97 degrees. Rather surprising was the fact that those cases with gangrene showed practically the same temperature changes. While temperatures over 100 degrees are not the usual finding, a small number of cases had a temperature of from 101 to 103 degrees. These temperatures were only slightly more frequent in those cases with gangrene. A rise in temperature of over 101 degrees occurred in a few cases without gangrene or marked damage to the bowel wall. These may probably be explained on the basis of dehydration.

There was no correlation between the temperature and leucocyte count. The mouth temperature, if taken when the patient is dehydrated and mucous membranes are dry, may give readings lower than the true temperature taken in the rectum. There was a rather constant increase in pulse rate which seemed to have a definite relation to the toxicity of the patient. The respiratory rate increased with the development of distention.

Distention varied with the duration and completeness of the obstruction. Some complete obstructions with gangrene had little distention when high in the intestinal tract or of short duration. Some partial obstructions demanding surgery had no distention.

Tenderness to palpation was present more often than one would assume from the writings on intestinal obstruction in surgical textbooks. Of 214 cases, it was noted as present in 167 and absent in 47. There was no typical distribution of tenderness. In many cases it was present throughout the abdomen. In those cases where a mass was palpable tenderness was most often localized or most marked in the region of the mass.

Rigidity was noted in 41 cases, 20 of which were complicated by the presence of gangrene. The terms 'tenderness' and 'rigidity,' as noted by different examiners, may be somewhat confusing but at any rate they seemed to have been more common than generally expected. We should like to be able to state the degree of damage to the bowel in those cases in which rigidity was noted and actual gangrene was not present, but this is difficult to do from records made by a number of observers.

The most important abdominal finding is increased peristaltic activity. Table II shows the occurrence of peristalsis. In determining the presence of peristalsis, auscultation is the most valuable method. Visible peristalsis was noted in only a few cases. Audible evidence of peristalsis was intermittent and was occasionally missed at first, during a cursory examination, only to be noted at a second examination. In a few high obstructions it was heard only in the epigastrium. In a few cases it was heard in one side of the abdomen and not in the other.

In this series there were 32 cases in which absence of or decreased peristaltic sounds were noted on physical examination and at operation no gangrene or peritonitis was found. Eighteen of these patients died, a mortality of 56 per cent. Comparing this with a mortality of 28.5 per cent for the entire number of obstructions without gangrene, we are impressed with the importance of diminished or absent peristaltic sounds as an indication of bowel injury even in the absence of actual gangrene.

In Table II, the data on absence of peristaltic sounds in gangrene of the bowel are shown. In a few of these cases peristaltic sounds apparently continued a short time after the occurrence of strangulation gangrene. However, in most cases the advent of gangrene stopped the audible peristalsis after a short interval. In other cases with marked distention, peristaltic sounds had ceased some time before the occurrence of gangrene.

LABORATORY EXAMINATIONS

Our observations regarding blood counts are not entirely in accord with statements in current

TABLE II—PRESENCE OR ABSENCE OF PERISTALSIS OBSERVED IN 177 CASES

	Cases Per cent	
Without gangrene	59	100
1. Increased	3	70
2. Present or normal	1	
3. Decreased	22	31
4. Absent		
With gangrene	18	100
1. Absent	5	27
2. Diminished	3	17
3. Normal		

surgical works which state that acute obstruction is not accompanied by a leucocytosis unless gangrene or peritonitis is present. Such factors as dehydration and in some instances the transmission of infective organisms through the bowel wall before actual gangrene occurs, make the leucocyte count difficult to evaluate. In those cases without gangrene, 61 per cent had a leucocyte count above 10,000 with 27 per cent above 14,000, and a few ranging above 20,000. In cases in which gangrene had occurred 90.5 per cent were above 10,000 and 66 per cent above 14,000. We think it is important to emphasize the fact that leucocytosis is not to be relied upon in determining the onset of gangrene. Of the cases with gangrene 33.3 per cent had a leucocytosis lower than 27 per cent of the cases without gangrene. It appears that the leucocyte count is not as reliable in determining advent of gangrene as the patient's other physical findings.

Urine examinations in this series did not show any typical findings.

Chemical examinations of the blood have not been done in sufficient number to draw conclusions. From a study of the literature on the subject, we feel that blood chemistry determinations have nothing like the value of the patient's symptoms and physical findings in determining the diagnosis and prognosis. Delay in order to make such determination would be inexcusable.

MORTALITY

The mortality of acute mechanical intestinal obstruction has not changed in the past 30 years. The mortality of this entire series is 42.7 per cent. The mortality rate in series of cases by operators in other large hospitals ranges from 23.5 per cent to 60.9 per cent. No attempt is made to compare these rates, for the series would vary as to types of cases included. There have been series of cases reported by single operators with mortality rates as low as 16 per cent. Research regarding the cause of death has added little of value in reducing fatalities.

We are startled to observe that the statistics in Table III do not indicate a higher mortality due to delay knowing as we do the positive danger of delay in the given case. Statistics notwithstanding delay in operation is not excusable. Every case of partial or complete obstruction carries with it the possibility of a damage to the blood supply of the bowel that cannot be determined before operation. In some of the cases obstruction was partial for a variable length of time before becoming complete or producing gangrene. It is difficult or impossible to select the case with which one may safely temporize. Table III also indicates the frequency with which the deaths, in the cases of obstruction that were operated on early are due to strangulation of a loop. It is obviously difficult to draw conclusions as to the increase of mortality due to delay in surgery when this type of case is included in the cases of short duration. If we omit the cases of gangrene and obstruction in infancy we have a mortality of 13.7 per cent for cases of acute obstruction without gangrene operated on in the first 48 hours. There were 46 cases in which delay in surgery occurred because of a diagnosis of partial obstruction. Some of these were cases of several days' duration at entrance, with a history of mild symptoms, presumably they were partial and delay was perhaps justified by that assumption. In other cases, partial obstruction was diagnosed and interference was delayed because results were obtained by an enema, or because there was little distention or the patient had a bowel movement after admission. Seventeen of these 46 patients died—a mortality of 36.9 per cent. In only 4 was there a gangrenous bowel found at operation. The mortality is higher than for all those cases without gangrene (28.5 per cent). In these cases, complete obstruction was not diagnosed even on entrance to the hospital and in many cases was not present at operation, apparently the longer duration, producing severe damage to the bowel was the factor responsible for the high mortality.

Mortality increases in proportion to duration of symptoms in cases of intussusception in infancy. There were 16 cases with 8 deaths. In 10 the duration was less than 48 hours and there were 3 deaths among these. Of 6 cases with a longer duration than 48 hours, only 1 recovered. Obviously intussusception diagnosed and operated upon early should carry a low mortality.

Table IV gives interesting data regarding the use of drainage of the bowel and enterostomy. In these cases draining the bowel at operation and closing the opening apparently did not accomplish the results hoped for. Table IV shows an

TABLE III—MORTALITY ACCORDING TO DURATION

	Cases	Deaths	Mortality per cent
24 hours or less	80	7	8.75
5 to 48 hours	11	10	90.9
49 to 72 hours	22	3	13.6
73 to 96 hours	41	10	24.4
97 to 120 hours	21	3	14.3
121 to 244 hours	4	9	225
45 hours and over (including partial obstruction)	58	26	44.8
Total	207	68	32.8

Summary of deaths in cases with duration of 48 hours or less

Gangrene by strangulation of loop

Intussusception in infancy

Concurrent carcinoma of liver

Not incomplete

Adenoma without gangrene

Bowel accidentally torn

9

1

increased mortality for the procedure, which does not seem entirely accounted for by the fact that the cases in which it was used were more serious than those in which the bowel was not opened. A comparison will show that the mortality equals that for resection of a gangrenous loop.

ENTEROSTOMY

In the few cases of obstruction in which enterostomy was done and the obstruction was relieved as well, the mortality again was as high as that for resection and anastomosis for gangrene. It was noted in some of these cases that enterostomy had not drained the partially paralyzed bowel effectively and that distention had continued. In this series of cases enterostomy has not reduced mortality, contrary to the claims of some writers. Enterostomy without relief of the obstruction was done in 8 cases of this series with 8 deaths. From these statistics it would seem that enterostomy does not preclude rupture of a gangrenous loop nor does it restore its viability and apparently it does not prevent the development of gangrene if the obstruction is not surgically relieved.

The results of the treatment of gangrenous bowel also are shown in Table IV. The cases in which gun barrel fistula was done may have been more serious than those in which resection and anastomosis was the procedure used. Admittedly it is difficult to draw conclusions from a series of cases done by different operators, but the mortality of exteriorization or gun barrel fistula is so high in this series that resection and anastomosis seems the procedure of choice except in a very few cases. Gun barrel fistula in this series of cases has not reduced mortality.

Factors in the high mortality of gun barrel fistula were (1) infection of the abdominal wound and peritoneum (2) digestion of abdominal wall (3) secondary operations necessary for closure.

In addition the patients in whom the gangrenous loop was in the first portion of the bowel became exhausted and emaciated from loss of intestinal contents, hence secondary closure was rendered very dangerous. Of the 12 deaths following gun barrel fistula, 5 were in frankly hopeless cases. Nine cases were apparently not more serious than those resected with an anastomosis, yet there were only 2 recoveries. Two of the 7 deaths in those cases in patients not moribund followed attempts at closure of the fistula. 1 patient died with findings of pneumonia. The other deaths were as nearly as could be ascertained from the records, of the usual type occurring in late obstruction.

TABLE IV—MORTALITY PATHOLOGY, PROCEDURE

	Cases	Deaths	Mortality per cent
Entire series	241	123	51.7
Obstruction without gangrene	175	40	22.8
a. Fracture of adhesions or reduction of obstruction, bowel not opened	148	33	22
b. Lateral anastomosis around the obstruction	14	7	50
c. Obstruction without gangrene in which the obstruction was relieved and drainage of the bowel of some type done	26	10	38.5
d. Drainage of bowel with closure	0	0	0
e. Obstruction relieved and enterostomy (ileostomy 5 cases jejunostomy case)	6	4	66.7
f. Accidental perforation of bowel	6	6	100
g. Removal of gall stones from bowel	1	1	100
h. Calcification with removal of adhesions	1	1	100
i. Circumcision with freeing of adhesions	1	1	100
j. Colonostomy with freeing of adhesions	1	1	100
Obstruction with gangrene	66	83	125.8
k. Resection and anastomosis	3	10	333.3
l. Enterostomy or gun barrel fistula	14	1	7.1
m. Moribund—died on table—no procedure attempted—etc. (In no case was the gangrenous bowel removed)	3	3	100
n. Localized gangrene due to bleed with no respiration of gangrenous segment	1	1	100
Recovery			

PATHOLOGY AND CAUSE OF DEATH

The clinical facts in this series of cases are explained best on a mechanical basis. Death results from damage to the bowel wall due to distention and strangulation. The exact manner in which death occurs is still in doubt, but the pertinent and essential facts are that it follows decreased viability of the bowel. Dragstedt has shown the importance of the factor of infection in a closed loop and many patients die with perforation of a gangrenous segment and general peritonitis. The necrotic loop may be toxic in itself when exposed to the absorptive properties of the peritoneum. Wangenstein has shown that in experimental obstruction there is very little absorption from the obstructed bowel and that the contents proximal to the obstruction are not more toxic than the contents distal to the obstruction. Toxicity from release of the contents of an obstructed loop

into the bowel distal to the obstruction was not observed in this series.

Much has been written about sodium chloride loss as an important factor in causing death from acute mechanical obstruction. In accordance with this theory administration of hypertonic saline has been advocated. Experimentally loss of chlorides has been shown to be a more important factor in high obstruction. Hypertonic saline has not been given in a sufficient number of cases in this series to warrant an opinion as to its usefulness but we wish to point out that in 95 per cent of 147 cases the location of the obstruction was in the ileum, or lower. Moreover while adequate amounts of physiological salt solution have been given in most of these cases after they entered the hospital we are impressed with the relation of mortality to evidences of actual damage to the bowel. In so called simple obstruction mortality increased with distention and with the absence of peristalsis and the usual sequence of events if operation is delayed is distention, absence of peristalsis, impaired viability of the intestine, with all the characteristic findings of peritonitis developing and death. In addition to the clinical evidence of these facts the following postmortem records are further evidence of their accuracy.

Autopsy findings are noted in 11 cases. Two cases were not operated upon. Both had a fibrinous peritonitis without actual gangrene. In 1 case there was also a lung abscess and pneumonia. Five cases at operation showed varying degrees of distention and congestion of the bowel. In all 5, release of the obstruction was the only operative procedure. In 3 a diffuse peritonitis was found in 1 bronchopneumonia and in 1 pulmonary embolism. In 3 cases intestinal anastomosis was done at operation and at postmortem examination a diffuse peritonitis was found. In 1 case a massive gangrene with numerous adhesions was found at operation and no procedure attempted. The postmortem examination showed a mesenteric thrombosis. While definite conclusions cannot be drawn from such a small number of cases yet these few autopsy records emphasize that actual damage of the bowel is the primary cause of death in intestinal obstruction.

From a study of these cases it seems that the essential factor in lowering the mortality of acute mechanical intestinal obstruction is the prevention of damage to the intestine from distention and the pressure of strangulation. Here once more applies the oft repeated exhortation to early diagnosis and prompt surgery—and may we add a word for the importance of skillful technique.

The measures which failed to emphasize or have allowed one to forget these needs have not produced results.

CONCLUSIONS

1. Enterostomy, drainage of the bowel, and gun barrel fistula have not reduced mortality in this series of cases as a matter of fact, those treated by these procedures show a very high mortality. We believe that a fistula, while it does have merits in certain cases, must be justified by careful consideration of the entire case before it is performed. Otherwise, it may increase instead of decrease the chances of death.

2. Simple obstruction without actual gangrene when delay has resulted in marked distention and absence of peristalsis, gives physical findings and mortality similar to that of gangrene due to strangulation.

3. The classification of obstruction into the strangulation type with gangrene and simple obstruction is difficult clinically and dangerous if it leads to delay in surgery.

4. Distinction between partial obstruction and complete obstruction is also difficult to make and delay in operating for partial obstruction leads to marked increase in mortality.

5. Many cases of obstruction occur from causes not apparent from the patient's history and physical findings.

6. We believe that an adequate enterostomy proximal to the resection of an obstructed and injured area will prove to be of great value.

7. Clinical study and autopsy findings show that mechanical damage to the intestine from distention and strangulation causing gangrene and peritonitis, or peritonitis before the development of actual gangrene is the usual primary cause of death in acute mechanical intestinal obstruction. However in addition to these pathological changes, one must never lose sight of the marked dehydration which is uniformly present in all cases of obstruction. In our opinion, the restoration of the body fluids with isotonic salt solutions, when administered by intravenous and subcutaneous methods, is a life saving procedure.

BIBLIOGRAPHY

1. BOWEN, G. O. and CLARK, JEFFERSON. Perforations anti-torcia—preliminary report based on treatment of 33 cases. *Am J. Sc.* 1928, 176:97.
2. BRILL. Surgical mortality of intestinal obstruction—analysis of 134 cases operated on at hospital of University of Pennsylvania. *Ann Surg.* 1929, 89:541-545.
3. BURDET, G. E., MARCHESSEY, K. and SECKOW, G. Relation of intra-loop pressure to condition of animal. *Arch Surg.* 1930, 21:839.
4. COHEN, E. A. *Boston M & S. J.* 1929, 183:430-437:451:458.
5. COLEMAN, E. P. *J. Am. M. Ass.* 1937, 83:1060-1065.
6. COOPER, G. H., STONE, C. S. and HILDEBRAND, H. R. Use of *Bacillus Welchii* (perfringens) antitoxin in experimental general peritonitis and intestinal obstruction. *Ann. Surg.* 1930, 89:461-657.
7. CORRY, D. C. Treatment of advanced cases of intestinal obstruction or strangulation. *Brit. M. J.* 1931, Feb. 7.
8. DRAVER, J. B. Intestinal obstruction. *Ann Surg.* 1926, 83:571-582.
9. DRAGETTED, C. A., LAMB, and MILLER. Relative effects of distention on different portions of the intestine. *Arch. Surg.* 1929, 18:2157.
10. ENNEMER, HARRY B. On the viability of the intestine in intestinal obstruction. *Ann. Surg.* 1925, 81:936.
11. Idem. Experimental intestinal obstruction. *Ann. Surg.* 1921, 74:524-609.
12. ELLIS, J. W. Cause of death in high intestinal obstruction. *Ann. Surg.* 1922, 75:420-425.
13. GATON, W. D., THURBER, H. M. and AVNER, E. D. Causes of death in acute intestinal obstruction. *Surg. Gynec. & Obst.* 1928, 46:332.
14. GERARD, R. W. Lethal agent in acute intestinal obstruction. *J. Am. M. Ass.* 1922, 79:1831.
15. HANSEN and ORR. Reducing the surgical risk in acute intestinal obstruction. *Am. J. Surg.* 1935, Oct.
16. Idem. Treatment of acute intestinal obstruction. *Ann. Surg.* 1930, 89:354.
17. HARTWELL and COOPER. Intestinal obstruction. *Lewis Surgery.*
18. HARTWELL, J. A. and HOGGUE, J. P. Experimental intestinal obstruction in dogs with special reference to cause of death and treatment by large amounts of normal salt solution. *J. Am. M. Ass.* 1912, 59:82.
19. HAYES and FOSTER. Studies on acute intestinal obstruction—simple obstruction. *Arch. Int. Med.* 1925, 26:31.
20. McKENNA, L. HIGON. Acute intestinal obstruction with special reference to ileus following operation. *J. Am. M. Ass.* 1923, June 9.
21. Idem. Drainage of the upper intestinal loop for the relief of ileus. *Surg. Gynec. & Obst.* 1913, 17:674-681.
22. McNICAR, C. S. Discussion of the clinical and laboratory clinical findings in certain cases of obstruction in the upper gastro-intestinal tract. *Am. J. M. Sc.* 1925, 169:224-235.
23. McNICAR, CHARLES, S. and WEIR, JAMES F. Nature and treatment of toxemia of intestinal obstruction and ileus. *J. Am. M. Ass.* 1929, 91:11.
24. MILLER, C. J. Study of 345 surgical cases of intestinal obstruction. *Ann. Surg.* 1929, 89:91.
25. MURPHY, F. T., and BROOKS, B. Intestinal obstruction—an experimental study of the causes of symptoms and death. *Arch. Int. Med.* 1915, 15:392-415.
26. OGDEN, ALTON. Acute intestinal obstruction. *Sect. Gynec. & Obst.* 1911, 51:702-712.
27. OWEN, J. C. and McCHESNEY, A. C. Peritonitis salutosa and experimental intestinal obstruction. *Arch. Surg.* 1929, 18:2237-2246.
28. SCHOLZ, B. G. Acute intestinal obstruction. *Guy's Hosp. Rep.* 1937, 77:160-83.
29. SUTTERLIN, FRANK. Acute intestinal obstruction. *J. Am. M. Ass.* 1919, 65:1890.
30. STONE, H. B. Clinical application of experimental studies in intestinal obstruction. *Am. J. Surg.* 1926, 1:252.

31. STONE, H. B., BRADSHAW B. M., and WHIPPLE, G. H. Intestinal obstruction study of toxic factors. Bull. Johns Hopkins Hosp. 1912 23 159-165.
32. SUMMERS JOHN E. Surg. Gynec. & Obst., 1921 32 412-414.
33. TUTTLE, H. K. Mortality of Intestinal obstruction 150 cases coming to operation or autopsy Boston M. & S. J 1925 192 791-795.
34. WANGENSTEIN, O. H., and CRUMH S. S. Studies in intestinal obstruction comparison of toxicity of normal and obstructed intestinal content Arch Surg., 1928, 16 606-614.
35. Idem. Arch Surg 1928, 16 1089-1111.
36. Idem. Simple obstruction study in the cause of death in mechanical obstruction of upper intestine. Arch. Surg., 1928, 16 1242-1255.
37. WANGENSTEIN, O. H., and GOMIN, REINHOLD O. Evaluation of the expulsion of enemata as a criterion of intestinal obstruction Arch Int. Med 1930 46 660.
38. WILLIAMS, B. W. Importance of toxemia due to anaerobic organisms in acute intestinal obstruction and peritonitis Lancet, 1927 Apr 30.
39. WILKES, BYRON C. Diagnosis and treatment of acute intestinal obstruction involving the small intestine Am J Surg 1930 8 33.

SPONTANEOUS RUPTURE OF THE COMMON BILE DUCT

A SEQUEL OF CHOLEDOCHOSTOMY

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RUPTURE of the common bile duct is an unusual accident. Either it is caused by trauma or it is spontaneous in origin, the trauma being the usual cause.

It has become increasingly frequent to interrogate the common bile duct by the direct method of incision and probing to obtain accurate information from within the channel, rather than to rely entirely upon an appraising eye or a palpating finger examining the outside layer and wall of the main biliary tube. Owing probably to the more numerous searches and intubations of the duct, we have had occasion to deal with 3 instances of duct rupture in the past 4 years. They have all followed choledochostomy. Our experience with the first case enabled us to make a pre-operative diagnosis in the 2 other cases.

The cases are reported in some detail because they depict a distinct clinical entity which may be recognized. We also offer a few suggestions that may help to prevent this grave complication.

REPORT OF CASES

CASE 1. I. F. aged 55 years, white female, had frequent attacks of gall-stone colic beginning 35 years ago. A gall bladder with calculi was removed 15 years ago. Following the operation, the pain recurred as before. During a very severe seizure of biliary colic associated with jaundice, the patient was admitted to the hospital and operated on (June 5, 1933). A choledochostomy was performed, a number of calculi in the common duct were removed, and a T tube was inserted. The postoperative course was uneventful; the jaundice cleared rapidly and the tube was removed on the twenty-fourth day after operation (June 27, 1933).

The patient was home and well for 10 days, when she had an attack of cramp-like pains in the abdomen radiating nightly to the right of the interscapular region, associated with epigastric distress, belching and rectal tenesmus, but without vomiting. This attack lasted for 3 hours. Following this episode, there was another seizure several days later which was more severe and of longer duration. This was accompanied by marked abdominal distention and regurgitation. The stools were large and foul smelling. One week following this second attack, the woman again suffered from excruciating cramp-like pains in the epigastrium, radiating to the right side and associated with nausea and vomiting. She was then immediately readmitted to the hospital (July 25, 1933).

Physical examination on admission. The patient was acutely ill, prostrated, asthenic, with a marked malar flush. The tongue was dry, the abdomen rigid. There was a sense of fullness in the right side of the abdomen with exquisite tenderness at the level of the umbilicus on that side. No fluid wave or shifting dullness was demonstrable. White blood count, 10,000 leucocytes per cubic millimeter of blood with 78 per cent polymorphonuclears. The urine showed albumin, graded 3 plus, red blood cells, and granular casts.

Temperature was 102 degrees F. The pulse rate was 100 per minute. Respirations were 22 per minute. An operation, with spinal anesthesia, disclosed an abdominal cavity filled with foul smelling blood. Biliary fluid which contained shreds of necrotic tissue. After the field was aspirated, a rupture of the common bile duct was visualized. Intraductal calculi were felt, but the condition of the patient precluded any attempt to remove them at the time. Three Penrose drains were inserted into the subhepatic area. The postoperative course was uneventful until August 14, when the patient had another attack of pain. A few months later, she was operated upon again for relief of common duct obstruction, and the calculi felt at the previous operation were removed. This time a drainage T-tube was left *in situ* for 7 months.

It is of interest that this patient was operated upon years later for a perforating jejunal ulcer for which a gastrectomy was performed. No ulcer was present at any of the previous operations.

CASE 2. R. B. aged 26 years, white female, gave a history of numerous attacks of biliary colic of 4 months' duration. During the last of these attacks she developed jaundice. On May 9, 1933, the operation notes revealed that the gall bladder was chronically inflamed, but non-calculous. The common bile duct was dilated and contained a cast of thick mucoid material. A choledochostomy was performed, followed by a choledochostomy, a straight rubber catheter being used for drainage. The postoperative course was uneventful, and the tube was removed on the eleventh post-operative day. The external wound was closed by June 7. Four days later the patient experienced a sudden attack of pain in the abdomen and back, and vomited undigested food. There was no constipation. Following this seizure, she was re-admitted to the hospital.

Physical examination. There was disclosed a healed upper right rectus scar and a rigid abdominal wall which was tender throughout. There was impaired resonance with distant breath sounds at both lung bases. Tenderness was definite in the left costovertebral angle. Icterus was noted. The temperature was 102 degrees F. The pulse rate was 108 per minute. Respirations were 22 per minute. White blood count 16,000 leucocytes with 65 per cent polymorphonuclear cells. The urine showed a faint trace of albumin and bile. The blood chemistry was normal. A diagnosis of acute pancreatitis was made and expectant treatment was advised. A roentgenographic study revealed that both diaphragmatic cups were obliterated by some subdiaphragmatic collection. The temperature mounted to 104 and 105 degrees F. The diagnosis was changed to that of spontaneous rupture of the common bile duct. The abdominal cavity was opened, a local anesthetic being used, and was found to be filled with bile and pus. When the field was suctioned off a rupture in the common bile duct was disclosed. Three cigarette drains were placed in the region of the duct and in Morrison's fossa. The postoperative temperature rose to 107 and 105 degrees F. The patient was given transfusions, stimulants, and parenteral fluids, but despite these measures, she died the next day. The culture of the peritoneal fluid showed *Bacillus coli*. No necropsy was obtained.

CASE 3. P. O. aged 42 years, white female, had suffered from biliary colic for 2 years. At times the accompanying

icterus was intense. During an operation on June 19, 1933, a small contracted gall bladder was visualized. The common bile duct was markedly dilated and contained calculi. A choledochostomy was performed with a drainage T-tube. The gall bladder was undisturbed. The postoperative course was uneventful except for a low febrile trend during the first 11 days. The tube was removed 2 weeks post-operatively and the wound healed.

She was re-admitted on August 31, 1933, with a 2 day history of pain in the upper abdomen associated with fever and jaundice.

Physical examination on admission. The patient was acutely ill, with the right upper quadrant of the abdomen tender and rigid, a healed scar in this area, a mild icterus, and moderate abdominal distention. The temperature was 101 degrees F. The pulse rate was 106 per minute. Respirations were 20 per minute. A diagnosis of spontaneous rupture of the common bile duct was made, and an operation was immediately performed under a local anesthetic. When the peritoneum was opened, a large amount of blackish-brown biliary fluid was disclosed. This was suctioned off. The patient's condition contraindicated any further surgical manipulation. Three cigarette drains and 1 gauze drain were inserted. The patient had a stormy postoperative course for the first 3 days, and then made a rapid and complete recovery.

A careful review of the literature has failed to reveal reports of similar cases, but they may be recorded under obscure or indefinite headings. From a critical study of these cases, one is impressed by certain striking and definite characteristics. In brief, the syndrome may be reconstructed in this fashion: A patient with a long history of biliary colic who may or may not have had a previous cholecystectomy, enters the hospital with definite evidence of common bile duct obstruction. The obstruction is relieved, the proof of patency of the duct is established, a choledochostomy is performed, and the patient recovers satisfactorily. After a time, the tube is removed and the draining sinus finally closes. Suddenly, the patient is seized with upper abdominal pains, vomits, becomes distended, is febrile, has a coppery red malar flush, is icteric, and prostrated. Rigidity and tenderness develop in the upper abdomen. Leucocytosis and polynucleosis are present. The abdominal cavity is re-opened, and is found to contain a tremendous amount of admixed biliary fluid.

Acute pancreatitis is the condition most likely to be confused with this syndrome. If it is realized

that a spontaneous rupture of the common bile duct may follow choledochostomies, an immediate abdominal operation will be performed instead of instituting any expectant treatment.

The etiology of the spontaneous rupture of the common bile duct is probably a subacute infectious process at the site of the choledochostomy. With the drainage tube *in situ*, this process is adequately protected. However, when the tube is removed and the common bile duct begins to heal, the granulations are soft and friable, and the exudate covering weak and insecure. Any undue strain on the wall of the duct at this point, because of increased pressure, may cause a rupture. Once the bile escapes into the peritoneal cavity, a widespread peritonitis may develop. That bile causes such a reaction has been proved by many investigators. There is also the possibility that many of the localized subhepatic pools that follow common duct intubations have resulted from a rupture of the duct, the collection being walled off from the general peritoneal cavity.

To prevent such a sequel to choledochostomy, we advocate that the T tube or rubber catheter, when removed, be replaced by a straight rubber tube of the same diameter into the original sinus. This tube is to remain for a long period of time so that effective removal of all infectious material may be maintained until the duct is given adequate opportunity to repair solidly the damage done by the trauma of the operation and the pathological process.

SUMMARY

1. Three cases of spontaneous rupture of the common bile duct are reported following choledochostomy.
2. The diagnosis may be made before operation by the recognition of this definite clinical entity.
3. Immediate operation under local anæsthesia is indicated.
4. The etiology of this complication of choledochostomy is discussed.
5. A means of prevention is suggested.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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CONGENITAL CYSTS AND FISTULÆ OF THE NECK

THE study of congenital cysts and fistulæ of the neck is of great interest from an embryological standpoint a knowledge of their development affords the surgeon not only an exact map for the field of action but also an understanding of the many intricate fascinating and rapid transformations of organic anlagen so that he is better able to cope with such tumors. In the main congenital cysts and fistulæ of the neck are divided into two groups median and lateral.

The median cysts and fistulæ have been recognized as having the course of the anlage of the thyroid which was discovered by His who found that in its course through the tongue this tract was always a solid cord never a tube with a lumen. At times high columnar and again pavement cell epithelium was found in the persistent thyroglossal duct and for the most part there were several parallel ducts with much lymphoid tissue around them and clusters of acinous glands. This did not conform with a thyroid tissue origin. Were these larger ducts formed by such acinous

glandular material? The epithelium is of such different appearance that this origin can be readily excluded. In early stages of the thyroid anlage we see a comparatively large lingual duct, the channel which leads from the foramen cæcum into the tongue and from the bottom of which the thyroid anlage develops. This lingual duct is not only relatively large but it has in addition branches which run in part parallel to the main channel. Even in the normal adult the channel leading from the foramen cæcum varies considerably in length. It is rather probable therefore that the thyroglossal duct is an abnormally long and persistent lingual duct. It has been argued that thyroglossal duct fistulæ never have an opening into the foramen cæcum. This is not correct however. It is true that a probe inserted into the fistulous tract is arrested chiefly at the hyoid bone but this is due to a kinking or to a local obliteration which very often occurs at this point. The hyoid receives cartilaginous form in the beginning of the fifth week of embryonal life when the normal thyroglossal tract has vanished. If a duct persists at that time the hyoid may develop behind it, which is the most frequent happening or it may include the channel, or in rare cases may develop in front of the duct. Very frequently the duct is kinked off or entirely obliterated at this point. However in some cases the whole channel could be injected. Takeda could inject the fistula even from the foramen cæcum and found that the injected fluid appeared in drops from the outer fistulous opening. The lymphoid tissue and the clusters of mucous glands accompanying the duct lumina can be

explained as having been drawn along from the surface. The great mass of lymphoid tissue at the base of the tongue called lingual tonsil, reaches anteriorly to the foramen cæcum. A thyroglossal duct which is still present in later life is probably the result of an abnormally long and persistent lingual duct which was drawn downward in the fourth week of embryonal life by the very rapid descent of the thyroid anlage. In the majority of the cases fistulæ are caused in postnatal life by perforation of a pre-existing cyst. An adenoma or a carcinoma may develop from an embryonal inclusion such as described and for this reason it will be worth while to study and make note of the exact site of the earliest beginning of a carcinoma of the base of the tongue, some of them have been found to have originated at the foramen cæcum.

The lateral congenital fistulæ are not as readily and as definitely understood as to origin as are the median ones. In the lateral fistulæ several embryonal structures are possible sources.

The second branchial cleft and pouch were thought to have a part in the formation of lateral fistulæ. This assumption was based on Rabl's demonstration at this location of a very long and narrow channel like formation (Rabl's duct). The assumption that lateral fistulæ originated exclusively from the second gill cleft was not accepted by other students of embryology. They believed that the other clefts, not the second alone, might be the cause of such cysts and fistulæ. Then, in 1912 Wenglowski after a thorough study of a large amount of material, published a report in which he concluded that the thymopharyngeal duct, because of the persistence and elongation of the primary thymus anlage which contains a vesicle was the sole structure responsible for the production of lateral cysts and fistulæ. The thymus is a derivative

of the third pharyngeal pouch. This view prevailed for a long time and undoubtedly in many cases, perhaps even in the great majority, the condition was brought about by such factors. This viewpoint did not remain unchallenged, however, for in 1927 Nylander published an account of his embryological research which led him to contradict Wenglowski's views inasmuch as he did not believe Rabl's decision was applicable in all cases. Nylander claimed that even the majority of the lateral cysts and fistulæ were due to a persistence of Rabl's duct. The surgeon can decide promptly in a given case whether he is dealing with one or the other variety of fistulæ, this is possible through his knowledge of the relation of the channel to the carotid vessels. In early embryonal life the external carotid runs straight upward from the common carotid, both vessels lying in front and mesial to the branchial apparatus. The internal carotid is the axis of the third branchial arch which it traverses from in front backward. Any evagination from the second pharyngeal pouch traverses therefore the space between the internal and external carotids, the internal carotid lying posterior, the external anterior to the fistulous tract. If the fistula involved is of the thymopharyngeal duct type, the tract must lead around the outer side of both carotids because the thymus originates from the pouch underneath the third arch. Future exact observations will have to be made to determine the relative frequency of the two origins mentioned. At present the question is still *sub judice*.

In a field in which rapid transformations take place as in the branchial apparatus with its derivatives many diverse embryonal inclusions are very possible, indeed, several rare isolated cases of fistulæ or cysts from other sources are described in the literature.

Embryonal epithelial remnants, according to Cohnheim's theory are a source of neoplasms

and in the branchial apparatus may give rise particularly to adenoma and carcinoma. A branchiogenous carcinoma of the neck near the bifurcation of the common carotid is not very infrequent. As in cases of carcinoma of the base of the tongue it will be of interest to investigate wherever possible, the exact location of the first appearance of the carcinomata of the tonsillar lodge. They are not so very rare and some of them may be due to a remnant of the lateral structures mentioned.

ARNOLD SCHWYZER

SURGICAL SHOCK

THE modern tendency in surgery is to classify all forms of acute circulatory failure complicating operations and wounds, except organic heart failure under the head of shock. The causes may be grouped under three general heads, namely, disturbances in vascular tone, disturbances in blood volume and disturbances of tissues and tissue fluids. The importance of the first two has long been known but that of the last has come to light only in more recent years.

Disturbances in vascular tone are brought about mainly through the nervous system. There is much uncertainty as to the rôle which they play in the production of surgical shock. Pure psychogenic disturbances may produce marked lowering of blood pressure as seen in ordinary syncope which shows many of the features of the shock syndrome. The systolic blood pressure may drop to as low as 50 or 60 millimeters mercury and slight bradycardia develop with resulting unconsciousness, but the reaction is, as a rule, of short duration. If a severe wound, resulting in pain and loss of blood, is accompanied by such a psychic reaction it greatly increases the likelihood of the development of a prolonged state of circulatory depression and may lead to shock. Af-

ferent impulses resulting from nerve stimulation from wounds and operations have long been held to precipitate shock independent of psychic action by directly influencing the vasomotor centers with consequent lowering of blood pressure. The mode of action has been variously interpreted as an exhaustion of the medullary vasoconstrictor center reflex inhibition of the vasoconstrictor center or stimulation of the medullary vasodilator center and there is as yet no unanimity of opinion.

Neurogenic fall of blood pressure is most definitely seen in connection with operations on the abdomen especially on the stomach and gall bladder in which it occurs in approximately 10 per cent of the cases. The anesthetic may be either local or general. The blood pressure falls during the early part of the operation and in the absence of hemorrhage. The various pathways of the causative afferent impulses that have been considered are the vagi, the splanchnics, the upper lumbar sympathetics, and the intercostoabdominal nerve roots. The reaction has been most frequently attributed to the vagus, but there are important objections to this theory especially since it is impossible to reproduce the condition by all types of stimulation of vagus fibers beneath the diaphragm. There is an accompanying mild bradycardia but the respirations show little change. The reaction passes off as the intra-abdominal operation is completed and has usually disappeared by the time the abdomen is sutured. Ordinarily it does no damage to the patient and unless blood pressure readings are taken the anesthetist and the surgeon may be unaware of its intensity. If the operation is prolonged and complicated by other shock producing occurrences as hemorrhage, it may assist in leading to a marked state of shock. Ephedrine usually causes its prompt disappearance and should be given if the reaction is prolonged.

There is much uncertainty as to whether or not stimulation of the large nerve trunks in other parts of the body ever causes a marked fall in blood pressure when psychic influences are eliminated. Cutting and pinching nerves at operation and electrical tetanization of nerves in experimental animals results in a rise rather than a fall of blood pressure. However, in cases of extreme injury and prolonged and extensive cutting operations where a number of blood pressure lowering factors may be active, it is often impossible to exclude afferent sensory impulses as a contributing agent.

Hyperactivity of the sympatho-adrenal system resulting in prolonged arterial spasm has been considered as one of the causes of shock, and the recent work of Cannon and Freeman supports this view. The eventual effect of the vasoconstriction is to damage the capillaries, increase their permeability, concentrate the blood, and reduce the circulating blood volume. More clinical evidence is needed for acceptance of the view that this is an important cause of surgical shock.

Loss of blood is of course the most important cause of acute circulatory failure and its significance is too well known to warrant discussion here. Suffice it to say that failure to recognize the extent of internal and even external hemorrhage often leads to the erroneous assumption that other factors are responsible for the state of shock. Loss of blood and psychogenic and neurogenic reactions are the three conditions that may bring about rapid fall in blood pressure with the accompanying picture of shock. However, a patient with a tumor of the adrenal medulla (pheochromocytoma) may be thrown into a critical state of high blood pressure and rapid pulse presumably from hyperadrenalinemia by an operation or injury (as a fracture of the hip recently observed) with a fall in blood pressure before the death.

Recent studies have shown that loss of plasma as by experimental plasmapheresis results in reduction of circulating blood volume, concentration, and stagnation of erythrocytes and a gradual fall in blood pressure with accompanying manifestations of shock. Blalock showed that sufficient plasma may be lost from manipulation of the intestines of dogs to create shock, but such an occurrence is rarely a complication of operations on man.

Alterations of the tissues and tissue fluids as a result of local injury or constriction of the circulation may lead to a state of secondary shock. The cause has been considered by some to be a toxin formed in the damaged tissues which enters the blood stream and produces general toxic symptoms. The toxic agent was thought to be histamine or a histamine-like substance in the case of both wounds and limb constriction. Recent experimental investigations have failed to show the presence of a toxic substance in the damaged tissues or circulating in the blood following either trauma or limb constriction. This does not exclude the possibility of the existence of traumatic toxemia. However, these investigations have also shown that as a result of extensive wounds there is escape of plasma or blood, or a combination of the two, into the tissues in quantities sufficient to create a state of shock. In some cases the blood vessels may be torn and hemorrhage may be the main cause of circulatory failure. If the limb is traumatized without tearing vessels the main cause is extravasation of plasma with a resultant blood concentration. The fluid producing the swelling in traumatized limbs has been found to contain as much as 5 per cent of plasma proteins. Prolonged limb constriction results in increased permeability of capillaries and following release, the part swells markedly from the escape of plasma into the damaged tissues. This dislocation of plasma

proteins may result in impairment of circulation and shock that proves fatal before signs of gangrene have had time to develop. Burns and freezing have been demonstrated to produce circulatory failure in the same way. Plasma proteins are gradually poured out into the damaged tissues in such quantities that marked blood concentration and reduction in circulating blood volume are brought about explaining the state of shock which may develop without the assumption of the formation of toxic substances.

Swingle and co-workers have reported that deficiency of adrenal cortex hormone results in increased permeability of capillaries and loss of plasma with blood concentration and serious reduction in circulating blood volume. They assume that this plays a rôle in surgical shock but clinical studies are wanting for substantiation of the view. Prolonged low blood pressure from any cause increases capillary permeability with loss of plasma and

eventually of erythrocytes with irreparable damage. Blalock has recently shown that this holds for hæmorrhage and that after blood pressure has been low from this cause for three or more hours abundant blood transfusion fails to arrest the escape of plasma and blood and to rehabilitate the circulation.

Clinical experience has shown that as long as permeability has not been seriously damaged low blood pressures usually respond to fluid administration—best to blood transfusion but also well to physiological salt solution. But when the permeability has become too great whether from nervous influences hæmorrhage local trauma, prolonged constriction, burns, or freezing the administration of fluids serves to increase the amount of plasma poured out of the circulation either locally or generally or both, and a fatal termination is the almost inevitable result.

D. B. PREMISTER

EARLY AMERICAN HOSPITALS

THE WOMEN AND CHILDREN'S HOSPITAL

BEULAH CUSHMAN B.S., M.D., CHICAGO ILLINOIS

TO write the history of the Women and Children's Hospital one must go back farther than the day when the doors first opened on the modest little dispensary and hospital that has gradually grown to an organization of its present size. One must go back to 1829, to the birth of Doctor Mary Thompson, who as a pioneer woman in medicine, organized the small unit to serve the immediate needs of women and children more or less destitute following the Civil War. She dreamed dreams as she worked tirelessly to realize her ambition—dreams that were kept alive, in spite of many trials finally to materialize into the present organization.

Doctor Mary Thompson was born in New York State, was educated in the East, and came to Chicago in 1863. She had been preceded by two women who had made an unsuccessful attempt to found a dispensary for women and children but their plans had been abandoned. At the time Doctor Thompson came to Chicago there were two hospitals in the city. Neither permitted women physicians to utilize their facilities and one did not accept women patients. At this time the Civil War was at its height. Medical facilities were limited for those not actually engaged in the war since most of the physicians had been enlisted for services on the battlefield. Drugs were difficult to obtain and few people had the money to pay for them. Friends of Doctor

Thompson appealed to her to help alleviate the suffering of the women and children of the city as well as of the many people who had migrated to Chicago from the East. She organized a dispensary and arranged with a group of druggists to provide medicine at reduced prices. Many of these patients, however were unable to benefit by the medical advice and care that she could provide because they in some cases had long distances to travel to and from the dispensary and were not in physical condition to stand the strain. Out of this pressing need, in the winter of 1864-65 the plans for the founding of a new hospital were formed. On May 8, 1865, a building situated at Rush and Indiana Avenue, was opened. It provided 14 hospital beds, a dispensary, and a drug room. During this first year the hospital treated 203 patients. The charge was presumably five dollars a week, but it is recorded that out of the 203 patients only one patient paid in full for her care.

In its second year the hospital had already outgrown its facilities and was therefore moved to a residence at 212 Ohio Street. It was while located here that the hospital met its first opposition. A petition was filed against it as a "nuisance." The original incentive for this move seemed to be that a man wished to rent for a stable the barn of the residence, which was serving at the time as a laundry for the hospital. The



The Women and Children's Hospital



Proposed plan for new hospital

charge was investigated, the health department reported that the laundry was clean and healthy and the institution was allowed to continue.

Three years later the hospital again needed larger quarters, and this time it was established at 402 N. State Street. It remained there until 1871 when unfortunately the hospital was one of the victims of the great Chicago fire. In 5 minutes, according to one dramatic report, the building was burned to the ground. The patients were transferred to another house but they were soon again forced to leave because the fire had spread. All of the material assets of the hospital were wiped out save for two pillows, a blanket and a piece of carpet.

With these remnants, at the instance of the late F. B. Gardner, Mrs. W. G. Davis, and other interested friends, a vacant house was taken at 598 West Adams Street, which was soon carpeted with mattresses and patients from attic to basement. No bedssteads could be had at the time. Here helpless women and children suffering from general sickness induced by fright, exposure to excessive fatigue and fire, followed by cold rains, were given food and medicine. On the 23rd of December, 1871, the Hospital was moved by the Aid and Relief Society to the Barracks on Throop and Harrison Streets. When the demands produced by the fire had ceased it moved in April, 1872 to 157 Center Avenue where it remained until the opening of the earlier building at Adams and Paulina Streets, February 26, 1873. In 1873, in acknowledgment of public service, the Relief and Aid Society gave the hospital \$25,000.00 with which the site at Adams and Paulina Streets was purchased. The commodious house on this site was transformed into a hospital, the small barn on the rear of the lot being used for the Women's Medical School. In 1873 it founded the first training school for nurses in the middle west. In 1885 the hospital moved into a five story brick and stone building specially planned for it. The new building at Paulina and Adams Streets, was opened December 10, 1885 and remained the home of the organization until the opening of the present hospital at Ashland and Maypole Avenues in January, 1939. The present building providing facilities for 100 patients.

In plancing through the records of the hospital one finds many interesting little touches that must have been of great significance to the hos-

pital. Food is frequently mentioned, from which we may gather that the endowment of the hospital was so meager that even its immediate needs had to be met by the generosity of friends. Pillow cases, garments for the patients, quilts, and similar equipment were provided by individuals and groups. Material for bandages was provided by gifts of old linen. The Third Presbyterian Church contributed one and a half gallons of wine.

The present hospital is a very different institution from that formulated out of the needs of Chicago during the Civil War. The hospital's staff is composed entirely of women physicians. It offers surgical, medical, and obstetrical care, maintains a well equipped X-ray department, which is adequate not only to aid in diagnosis but also to carry out treatment as indicated. The hospital also operates the third largest dispensary service in the city. The Emergency Welfare Relief provides a fund for the care of 20 hospital patients and 65 dispensary patients a day. The institution sustains a standard of work that makes it acceptable by the American Medical Association for the training of internes. A home for nurses was maintained from 1873 to 1930.

One of the unique branches of the work of the hospital is The Mother's Milk Bureau organized and established by Dr. Bertha Van Hoesen in 1930. This organization furnishes mother's milk to the hospitals in the city for babies who are undernourished or for some reason do not tolerate the usual artificial formulas. The milk is obtained from mothers who have undergone very complete physical examinations, and whose babies not only are not using all of the milk the mother has, but are also found to be doing well on the mother's milk; they are consuming. The donors and their babies are carefully supervised to ascertain that the mother eats properly and that her own baby is not being sacrificed for the financial remuneration the milk brings. The milk is collected with great care in special food containers, and is never used if more than 24 hours old. The Bureau distributes about 1500 ounces a month, part of that being given away to families unable to pay for it, for the slogan of the organization promises that no baby in Chicago shall die for lack of mother's milk. This department was founded in 1930 and has its distributing center at the Women and Children's Hospital.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

TO us as medical students 20 years ago two textbooks of surgery seemed to stand out from a considerable number of available and popular one volume works because of their conciseness, their clarity of expression, and their stimulating interest. To these, Stewart's *Manual of Surgery* and deQuervain's *Surgical Diagnosis* has in recent years been added a third,¹ which is the best single volume work covering the field of surgery that we have had the opportunity of reading.

The necessity for a third edition of Homans' *A Textbook of Surgery* only 4 years after its introduction to the medical profession indicates how popular it has become in this short period. Many features contribute to this well deserved popularity: the book is first of all, an attractive and pleasing example of the book maker's art: the illustrations are well chosen, carefully drawn, and truly illustrative: they do not detract from the subjects concerned by excessive size and needless emphasis on trivial details: the historical sketches which introduce many subjects provide a background which is both interesting and essential to the student who would truly grasp surgical principles and practice: the bibliographical index is exceptionally complete and ingeniously arranged to enable the reader to find quickly the source of the author's material. Finally and of greatest importance, is the well balanced presentation of the tremendous number of subjects included in general surgery. To have taken the lectures and papers of many different individuals interested in widely separated fields of surgery to have welded them into a homogeneous whole to have filled in the many and extensive gaps untouched by the author's associates, to have omitted so wisely the obsolete material that has been allowed to encumber many of the older books, and to have produced finally a thoroughly interesting, readable and well considered textbook of surgery seems to us an admirable achievement and one that deserves unstinted praise.

With specific reference to the new edition the publishers list on the inside page of the jacket some thirty subjects "which have undergone correction or been newly introduced in the third edition."

The new material in the author's prefatory words, has been incorporated without a change in pagination under the plan that for everything fresh that comes in something stale must go out. We have not been able to recognize the stale that has gone out but have seen many evidences that the author

has labored diligently to include in this new edition the worth while contributions of the past few years.

SUMNER L. KOCH

ANY literary work which reaches its fourteenth edition and which has been translated into seven foreign languages has achieved a position of unquestioned importance. May's *Diseases of the Eye*² made its first appearance in 1900 and for many years has been probably the most widely used text on the eye for general practitioners and medical students, both in the United States and in several other countries. During the past year the seventh British, the ninth Spanish, the sixth Italian, and the third Chinese editions have been issued.

The secret of this wide universal acceptance has been the fulfillment of the original conception of the author to create a book on the eye not for the ophthalmologist but for the student of medicine and the general practitioner of medicine. Theoretical considerations, detailed discussions and descriptions, and the more unusual ocular conditions are carefully avoided or only briefly mentioned. The language is concise, simple, and explicit. There are many excellent illustrations, including two new colored fundus plates.

Much of the material has been rewritten for this fourteenth edition in an attempt to eliminate the obsolete practices usually carried along from one edition to another in works of this kind. The newer treatment of retinal detachment has been ably handled and brought up to date: there have been revisions on anatomy, pathology and ocular motility.

It may be questioned that ophthalmological optics and refraction should be assigned 63 pages in a work of this scope, intended for and used by the man in general medicine and not by the specialist. It is too detailed for the former and insufficient for the latter. Many minor criticisms might be offered on such points as the rôle of the staphylococcus in the production of acute conjunctivitis, the importance of pain as a leading symptom of retrobulbar neuritis, the rather frequent mention of the use of leeches, and similar points not strictly in keeping with modern practice.

The fine points of this book are too numerous for a few faults to outweigh them and with the improvements and revisions of the present edition it should

¹ A TEXTBOOK OF SURGERY. By John Homans, M.D. 4th ed. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1925.

² MANUAL OF THE DISEASES OF THE EYE, FOR STUDENTS AND GENERAL PRACTITIONERS. By Charles H. May, M.D. 4th ed. rev. Baltimore: Williams Wood & Co. 914.

continue to occupy first place in popularity among students and practitioners of general medicine.

WILLIAM A. MARR, JR.

THE new edition of *A Textbook of Bacteriology*¹ by Zimser and Bayne-Jones, is remarkable for the extent to which it has been brought up to date. But even more so is the element of fair judgment with which the authors have evaluated the wide variety of recently published articles.

Even the recent medical graduate who examines this book will find evidence of new and major advances in the subject of bacteriology with definite bearing on clinical medicine. The older graduate will note that a veritable flood has passed under the bridge since his day as student of this science.

The authors have taken a definite forward step in selecting and presenting materials so as to indicate the application of bacteriology and immunology to clinical medicine rather than to present the strictly diagnostic aspect. Yet at the same time they have made available a wealth of information which has been adequately digested and correlated so as to elucidate biological principles.

This book has particular value as a reference volume, giving to its reader information published as late as 1934. The material has been fairly judged by the authors and presented in a manner that makes it readily available. As to its use as a textbook for medical students one wonders if the average medical curriculum allots to the course in bacteriology sufficient time for the student to cover adequately the essentials in this book.

The chapters on the bacteriology of milk and water have been eliminated, to provide, as stated by the authors in the preface, space for a presentation of some of the great mass of newly acquired material. One wonders if the time has not come when the chapter on parasitology can be omitted from textbooks of bacteriology and given over to the protozoologist, for parasitology seems in some respects less related to the science of bacteriology than does the bacterial content of milk and water and their sanitary significance.

The recent developments in bacteriology have more prominent place in this book.

The newer infectious diseases as tularemia and undulant fever are more extensively described and discussed than usual.

Among the more recently developed and important fields of immunology bearing directly on clinical medicine is that of the soluble specific substances. This subject is adequately handled, as would be expected since the senior author was a pioneer in this field. Bacteriophage therapy is discussed in the light of recent experimental studies, and its value as a therapeutic agent is questioned. More space might have been devoted to the presenta-

tion and discussion of the experimental evidence on which the authors based their conclusions, since bacteriophage has been so widely heralded as a panacea in the treatment of infections.

In this book the authors have emphasized the facts and established principles of the science of bacteriology. The unsettled and theoretical has been fully presented and different opinions on controversial subjects presented and controversially discussed.

ARTHUR W. WALKER.

THE recent publication of the fifth edition of Professor Folin's *Laboratory Manual of Biological Chemistry with Supplement*² again brings to date a volume outstanding because of the originality and productivity of its author whose methods comprise a large part of the contents. The arrangement is the same as in previous editions, the material designed essentially for class instruction being arranged in a series of ten parts dealing with elementary considerations of volumetric analysis, catalysis and enzyme action, fats, carbohydrates, proteins, urine analysis and metabolism blood, bone, and bile. Wherever possible quantitative methods of study are presented, there being a minimum of purely qualitative experiments.

The discussion (Part 1) of the essential elements of chemical equilibrium, the proper selection of an indicator for titration and what occurs during the titration of an acid and base, is so clearly and simply presented as to be within the comprehension of any non-mathematical student. One wishes, however, that a few simple experiments had been devised to illustrate the principles discussed. The material contained in Part 5 on proteins is devoted chiefly to color reactions and precipitation tests. In view of the amphoteric nature of protein, it seems to the reviewer that a section devoted to colloidal chemistry, or to a few experiments illustrative of the colloidal behavior of proteins could be added with advantage. An experiment on the isoelectric precipitation of protein would acquaint the student with a method in general use in research and industry today. The methods of quantitative urine analysis are introduced in Part 6. Significant changes have been made in the uric acid method which diminishes the interference by polyphenols and other substances. Parts 7 to 10 remain the same as in earlier editions.

Probably the most valuable material of the book is contained in the supplement. The section has undergone the greatest revision. Professor Folin has discussed in detail the various steps in the more complicated procedures of blood and urine analysis where difficulty may be experienced in learning the methods. In the section on urinalysis a tentative colorimetric method for the determination of phenols has been introduced, Lloyd's reagent and carotic acid being used to remove the interfering uric acid. In the section on blood analysis the use of an unlabeled

¹ A TEXTBOOK OF BACTERIOLOGY, WITH SECTION ON PATHOLOGICAL IMMUNOLOGY. THE APPLICATION OF BACTERIOLOGY AND IMMUNOLOGY TO THE DIAGNOSIS AND TREATMENT OF DISEASE. 1934. 10th Edition. By Hans Zimser, M.D. and Kenneth Bayne-Jones, M.D. 7th Edition. New York and London: D. Appleton-Century Co., Inc.

² LABORATORY MANUAL OF BIOLOGICAL CHEMISTRY, WITH SUPPLEMENT. BY OTTO FOLIN, Ph.D. New York and London: D. Appleton-Century Co., Inc. 1934.

blood filtrate originally devised for the determination of uric acid, has been extended to the methods for blood sugar, creatinin, and non-protein nitrogen. The author justifies its use in the following statement: 'Doubtless there is still room for differences of opinion as to whether indiffusible fixed materials of the red blood cells should or should not be included in some of the analyses, but the view is taken here that the inclusion of suddenly disintegrated cell materials does not belong in the determination of the levels at which definite well known materials are being transported to and from tissue. New micro-methods, with but 0.2 cubic centimeter blood have been introduced for the estimation of non-protein nitrogen and uric acid, together with the author's well known micro-method for blood sugar which requires but 0.1 cubic centimeter blood. Explicit directions for the purification of reagents required in these as well as in other procedures, are given.

As in previous editions, the methods for inorganic constituents of urine and blood devised by Professor Fiske and associates, and for total fatty acids and cholesterol in blood plasma by Professor Bloor have been incorporated.

Not only does this volume fulfill its purpose as a laboratory manual for medical students, but it is especially valuable to all engaged in routine blood and urine analysis and research. C. J. FARMER.

THE Cancer Control Organization for Edinburgh and Southeast Scotland was inaugurated on March 2, 1934. The purpose of the organization is the investigation, the care and the control of cancer. The volume reviewed here is the first publication of the new organization and presents a statistical survey of the results of the treatment of cancer in the Royal Infirmary.¹

The introductory chapter consists of the chairman's address by Mr. J. J. M. Shaw. If this small volume contained nothing more than the chairman's address, its publication would have been fully justified. Those who have attempted to pronounce a brief but comprehensive statement of the cancer problem to a mixed audience fully appreciate the difficulty of this task. Mr. Shaw has accomplished this task admirably. The presentation is clear, concise and beautifully composed. The point of view is sound and well balanced. No one who is interested in the subject of cancer control should fail to read it.

Three hundred and thirty three cases of carcinoma of the female breast and one carcinoma of the male breast are analyzed. The radical operation, sometimes combined with radiation, has been the treatment of choice in the operable group. Cancer of the tongue is treated by interstitial radiation.

It is quite evident that one of the important handicaps in the work of this institution is the inadequacy of radium facilities. The radium bomb does not contain sufficient radium to prove an

effective instrument. The minimum must be one gram, preferably it should contain two grams.

The publication contains further statistical data and the methods of treatment of other forms of neoplasm. It is quite evident from this publication that this group is making a sound and intelligent effort to execute modern cancer therapy.

MAX CUTLER.

A REMARKABLE book is *Cirugia Gastrica*.² The author Manuel Corachán, is a distinguished professor of surgical pathology in the medical school at Barcelona and chief surgeon to a large hospital. He has had a large clinical material, and one needs only to glance at the extensive and well chosen bibliography scattered throughout the book to see that he has been a tremendous reader. Remarkable for a European is the fact that he is thoroughly conversant with American contributions as well as with those of his own country France, England, and Germany. The book is beautifully printed on fine paper and it is beautifully bound. It would be a source of lifelong pride to any publisher in the world. The illustrations are many and they are well reproduced.

Particularly remarkable is the lavishness with which good colored photographs have been used. Many of the roentgenographs are particularly interesting because the technique of Berg and others has been used to show the folds of the gastric mucosa.

It is unfortunate that so few American surgeons read Spanish, for there is much in this book to interest and help them. Actually there is no book in English covering the field so extensively or so beautifully as this volume and its companion will do.

A large part of the book is taken up with hints on the examination of the patient. There is much valuable material also on the anatomy, physiology, and pathology of the stomach. There are beautiful colored representations of what can be seen through the gastroscope.

Much space is given, as one would expect to the problems of ulcer and cancer. In addition many pages are given to the discussion of the rarer lesions of the stomach.

The author gives more space to problems of gastritis and gastropnoia than most American surgeons would give. So far as operating for ptosis goes, he points out wisely that even if an operation is done the patient must be treated medically for a long time with rest and an over feeding diet.

About the only criticism that one might make after reading here and there through the book is that the author might well have trusted more to his own experience and wisdom and less to his extensive knowledge of what others have written. The physician or surgeon looking for help is grateful to the man who has prepared a good review or abstract of the literature, but often he is even more grateful for frank statements by a man of wide experience.

¹CANCER—EDINBURGH 914 Published by The Cancer Control Organization for Edinburgh and Southeast Scotland, Edinburgh E. & S. Livingston 1934.

²CIRUGIA GASTRICA By Dr. Manuel Corachán Vol. I Barcelona Salvat Editores 1934 (715 pages).

The second volume is to contain chapters on pre operative and postoperative care, anesthesia indications for and technique of, the various operations on the stomach, rare or disused operations, the stomach that has been operated on, the results of the various operations, and the bad results sometimes obtained after gastro-enterostomy and gastrectomy.

CHARLES H. MAYO
WALTER C. ALVAREZ

THE volume¹ entitled *Foreign Body in Air and Food Passages* by Drs. Chevalier and C. L. Jackson has long been awaited both by the roentgenologist and endoscopist and neither will be disappointed as it fulfills all pre publication expectations. Coming from the pen of the Jacksons it is quite natural and necessary for it to be simple and lucid yet complete in every detail.

The book falls into eight main sections devoted chiefly to differential diagnosis of both radiopaque and radiopaque foreign bodies from an X-ray standpoint although the associated pathology is not neglected. Accompanied by 150 X-ray reproductions with descriptive legend of all types of cases there is very little if anything overlooked. Thus it is very easy to follow the authors through the description of a drowned lung as compared to a pulmonary abscess or what the roentgenologist might expect from the reaction of tissues to foreign bodies of certain chemical or physical properties.

A very valuable chapter is devoted to fluoroscopic endoscopy in which the biplane fluoroscope is used to great advantage.

The book is filled with valuable axioms learned from years of clinical experience and over 3,000 cases of foreign body in the air and food passages. Written from such a large store of material it deserves high praise for concrete knowledge it discloses and its quality will give it more than a temporary success.

JOHN F. DUFF

IN the third edition of Slemmons' book² on the prospective mother changes have been made in many subjects, especially the arrangement of the diet the gain in weight during pregnancy the employment of the X-ray for greater accuracy of diagnosis the rôle of the endocrine glands in the menstrual cycle and the modern methods of anesthesia at the time of birth.

The reviewer has never believed that pregnant women should be told as much of the anatomy and physiology of pregnancy and labor as this book discloses. The smattering of information which the patient obtains is apt to be misapplied and misinterpreted.

Teachers of obstetrics realize how difficult it is for medical students to grasp the normal in obstet-

A HALL OF ROENTGENOLOGY. SERIES OF MONOGRAPHIC ATLASSES. Edited by James T. Case, M.D. Vol. VII.—FOREIGN BODY IN AIR AND FOOD PASSAGES. By Chevalier Jackson, M.D. and Chevalier L. Jackson, M.D. New York: Paul B. Hoeber, Inc. 1924.

THE PROSPECTIVE MOTHER, A HANDBOOK FOR WOMEN DURING PREGNANCY. By J. Morton Slemmons, M.D. New York: D. Appleton-Century Co. Inc. 1924.

rics. What sort of grasp will the layman get in this short course in obstetrics?

The rest of the information is well given.

In the reviewer's opinion all the information a lay woman needs on the subject of the prospective mother could be stated in fewer than 321 pages many obstetricians find a booklet of 16 to 20 pages ample.

To those who do not agree with him, the reviewer recommends this as a good book.

EDWARD L. CONTELL

THE discovery of the sympathetic nervous system by the surgeon has been a recent affair though the neuro-anatomist and physiologist have been contributing for many years to our knowledge of this regulator of our body's internal economy. Like most fundamental discoveries in science the facts set forth by these experimentalists became general property only when it was shown that somehow and in some way the involuntary control over our blood vessels, glands, and viscera might be influenced by various surgical operations.

So rapid was this invasion of a new surgical field that many procedures were advocated which opposed all known anatomical or physiological facts. In truth, it was only after several years, during which the literature was crowded with publications, that surgeons found that many times they did not fully understand one another. So we find them now solemnly emphasizing that by the "sympathetic system" they mean that part of the autonomic nervous system represented in the thoracic-lumbar outflow. Familiarity with the known facts in the beginning might have made surgical progress more sure and perhaps less bombastic.

During the last 10 years claims for the relief of the spasticity of muscles following lesions of the central nervous system have been disproven step by step. Recently the careful reporting of observations upon patients operated upon for vascular diseases of the extremities has added to the scientific data which must be balanced in the final judgment upon operations designed to give much needed relief to unfortunate patients. It is unfortunate that the critical, unprejudiced judgment of the laboratory worker is not always employed by the surgeon in evaluating the results of his operations. Surely it is not enough to say empirically "the patient was benefited better."

Early in their book,³ Gaak and Ross lead one to believe that their evaluation of the surgery of the sympathetic nervous system is to be a critical one. Unfortunately they do not bow to the line throughout for example, their acceptance of Lewis' contention that removal of the sympathetic supply to an extremity does not prevent the occurrence of attacks of vasoconstriction in Raynaud's disease. Careful examination of surface temperature changes properly

"THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George E. Gaak, C.M.B., D.B.O., F.R.C.S. (Eng.), and J. Harrison Ross, M.D. (Lond.), F.R.C.S. (Eng.). Baltimore: Williams Wood & Co. 1924.

controlled and of blood volume changes in the fingers will support that view. These are the facts which the surgeon can add which will be of some ultimate value. It is surprising that the authors, after pointing out correctly that the assumption on which periarterial sympathectomy was based is incorrect devote so much space to the subject and do not insist upon an evaluation of the claimed clinical results similar to those employed by Lewis in his study of the results of operations for Raynaud's disease. Again, we read "It would be unwise to advocate this operation (periarterial sympathectomy) in the treatment of Raynaud's disease or thromboangitis obliterans, though occasionally an astonishing improvement may occur in the latter disease."

The strongest argument for periarterial sympathectomy would seem to be the statements that pain of vascular origin is relieved. Certainly, it should be pointed out that not all cases of causalgia can be relieved by such an operation. Inasmuch as the nerve supply to the vessels of an extremity is segmental, and since it has been shown that there is no pathway for afferent painful impulses along the course of the vessels, it is difficult to understand how the pathway is broken unless by chance the operation is performed above the site of the lesion the exact nature or location of which is commonly unknown.

It is disappointing that the battle between their obvious sense of the application of physiological criteria to the results of their operations and their surgical belief that some clinical good must come of an operation for which they have no scientific factual basis, should have led the authors to champion surgical procedures rather than record their results in graphic data which could be interpreted by their readers. For example, does a patient with removal of the periarterial nerve supply to the radial or brachial artery respond to a stimulus of the lumen of that vessel below the site of the operation?

Finally that the authors realize the necessity for keeping an open but critical mind on this entire business of the surgical attack upon the sympathetic nervous system is obvious in their last sentence.

"until more is known about the pathology of the sympathetic system, the place of surgery in the treatment of its disorders cannot be firmly established."

L. D.

THE author of this monograph, Dr. McIver, has presented a remarkably clear and comprehensive picture of the problem of acute intestinal obstruction from both the clinical and experimental viewpoint.¹ It is the best analysis that has yet appeared and deserves a place with the classic papers in this field. The author and his associates have made a very important and fundamental contribution to our knowledge of the cause of death in acute intestinal

obstruction but this achievement has by no means blinded him to the work of others. He is thoroughly acquainted with the voluminous literature and very few worth while contributions have escaped his critical survey. The first section of the book gives a general picture of the disease and a discussion of the underlying pathological lesions responsible for various types of mechanical obstruction. The importance of the level of the obstruction and the condition of the circulation in the mesentery and intestine is emphasized. There is a thorough discussion of the symptomatology and an excellent summary of the changes in the chemistry of the blood and in the body fluids, a field in which the author has made such a signal contribution.

The diagnosis of acute obstruction is based upon the clinical symptoms and upon X-ray examination with or without a barium enema. Laboratory studies are usually of little aid, since changes in the blood chemistry may not be present in some cases, and appear too late in many others. The section on treatment emphasizes the necessity of prompt operative intervention. While the replacement of fluid and restoration of the altered blood chemistry is important, operation must not be too greatly delayed on this account. Decompression of the stomach and the obstructed intestine by means of a duodenal tube with moderate suction is described. The author however wisely reserves judgment regarding the general applicability of this method and is concerned lest its adoption postpone surgical treatment.

The surgical treatment of acute intestinal obstruction is thoroughly described and the usefulness of enterostomy is emphasized. The sections on pre-operative and postoperative treatment and the methods of handling high intestinal fistulae and other similar complications are especially instructive.

The last section contains an excellent critical summary of the experimental work that has been done to determine the cause of death. The relative significance of dehydration, due to loss of the various digestive secretions, and toxemia due to absorption from the proximal intestine, in obstructions at various levels in the gastro-intestinal tract and with varying degrees of circulatory interference to the bowel wall is ably presented and the conclusions drawn are logical in the light of present knowledge. Every general surgeon and everyone interested in the problem of intestinal obstruction from the experimental standpoint should read this book.

LESTER R. DRAGSTEDT

THE first edition of Stokes' excellent monograph on syphilology was published in 1926. In the second edition,² the book has been enlarged and 15 of the 23 chapters have been rewritten. A new chapter on relapse and progression is another improvement.

The first edition had, as a definite aim, the presentation of the subject to the completely uninitiated

¹ HOBBS'S SURGICAL MONOGRAPHS. ACUTE INTESTINAL OBSTRUCTION. By Monroe A. McIver, M.D. New York: Paul B. Hoeber Inc., 1934.

² MODERN CLINICAL SYPHILITIS. DIAGNOSIS, TREATMENT. By John H. Stokes, M.D. 2nd ed. rev. Philadelphia: W. B. Saunders Co. 1934.

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LATE COMPLICATIONS IN IRRADIATION TREATMENT OF CANCER OF CERVIX¹

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THE effective treatment of cancer of the cervix uteri necessarily carries considerable risk to the patient. The risk is less with irradiation than with operation, but irradiation carries definite dangers. The serious responsibility and difficult problems in the use of radium in this situation are not generally appreciated. If the dose is too small, the distant cancer cells survive and the patient dies of recurrence. If the dosage is pushed to the point of causing devitalization of the outlying cancer cells, there is danger of irradiation injury of the rectum and bladder and the ureters.

To give the patient the best chance of cure and at the same time to hold local injury to the minimum require expert study of the particular conditions present in the pelvis in each case, and a careful adaptation of every means to the administering of the maximum dosage permitted by those conditions. In this work thorough knowledge of pelvic anatomy and pathology with training and experience in accurate palpation must be combined with radium knowledge and experience in order to give the patient the chance for life to which she is entitled. Hence anyone who attempts this work should have substantial training in both gynecology and radiology.

In the Washington University Medical School and Barnes Hospital, we have been

using radium and X-ray therapy systematically and fairly uniformly since 1921. Our cases have been analyzed and 5 year cures and other features reported from time to time.² The object of this paper is to call attention to certain late complications encountered in the 371 irradiation cases treated from July 1, 1921 to January 1, 1933. The disturbances under consideration are noticed one to several years after treatment, hence the series includes only cases treated prior to 1933.

These late complications are apparently due to slow vascular changes resulting in localized tissue devitalization. Also present are slow infiltration and necrosis with resulting contraction. Considering the intensive irradiation required for this deep seated cancer these lesions are rare in noticeable grades as evidenced by the small number in this series. This type of lesion was found in the rectum as a stricture, in the bladder as an indolent ulcer, and in the skin as a persisting and increasing subcutaneous infiltration leading occasionally (in one case) to extensive necrosis. The amount of radium employed was approximately 100 milligrams and it was screened with $\frac{1}{8}$ millimeter of silver and 1 millimeter of brass. In addition, the capsules were placed in soft rubber tubing and distance

¹Ann. J. Obst. & Gynec., 1931, 23: 159, 1933, 24: 167. Surg. Gynec. & Obst., 1934, 53: 450.

²Presented before the Texas Association of Obstetricians and Gynecologists, San Antonio, Texas, September 30, 1931.

screening of the bladder and rectum was secured by firm packing adapted to the particular conditions present. In most of the cases of this series, the course of treatment was started with the radium implantation. The details of the X-ray treatments are given in each case showing subcutaneous infiltration

RECTAL STRICTURES

CASE 1. J. P. aged 44 years, in May 1933 received 4800 milligram hours of radium for a squamous cell carcinoma of cervix of clinical stage II. League of Nations International Classification. In this case radical abdominal operation was employed, the operation being carried out a few days after the finish of the radium dosage (which was given in two treatments with an interval of 4 weeks). Following the operation the patient received deep X-ray therapy.

Two years after treatment (August 1935, a rectal stricture was found. It was adjacent to the cervix area where the radium had been applied. It admitted the tip of the finger and was easily dilated, the walls being thin and without extensive induration. There was no indication of cancer in the rectum or elsewhere. In 1938 there was still slight narrowing but no symptoms from it. In June, 1939, there was no disturbance from the rectum or vicinity and no evidence of cancer. In February, 1931, the patient developed symptoms of brain tumor from which she died 4 months later. No evidence of cancer in pelvis. An autopsy was not obtained.

CASE 2. B. S. aged 46 years. In October 1930, patient received 4500 milligram hours of radium for squamous cell carcinoma of cervix of clinical stage III and also the usual deep X-ray therapy. In July 1932 there was definite rectal constriction in the cervical region. This was easily kept open so that there were no troublesome symptoms, but there was still some constriction at examination in June, 1934. There was no evidence of recurrence of the carcinoma. This patient had also a second degree X-ray infiltration of the abdominal wall (see under late X-ray effects).

CASE 3. S. L. aged 43 years. In September 1931, patient received 3000 milligram hours of radium for a squamous cell carcinoma of cervix of clinical stage III, followed by deep X-ray therapy. In a routine check-up examination in September 1933 a rectal stricture was found opposite the cervix. It was wide and admitted the finger easily for dilatation and had given no special trouble. In April, 1934 the rectal stricture was about the same. There was no evidence of recurrence of the cancer.

CASE 4. S. G. aged 61 years. In September 1932, patient received 4000 milligram hours of radium for squamous cell carcinoma of clinical stage III and the usual deep X-ray therapy. Check-up examination showed no evidence of recurrence of the cancer

but in the examination in August, 1933 a rectal stricture was found. This was adjacent to the cervix, and the walls were thick and firm. The opening was small and was dilated with some difficulty. In March, 1934, the stricture was causing no trouble. It is to be noted that this stricture gave trouble about a year after treatment, while those previously mentioned were not noticed until 2 years after treatment.

CASE 5. L. F., aged 45 years. In February 1932, patient received 3000 milligram hours of radium for squamous cell carcinoma of cervix of clinical stage III and also deep X-ray therapy. This case gives a clear indication of the etiology of these strictures. We have come to expect considerable rectal irritation in the effective irradiation treatment of carcinoma of the cervix, the rectal mucosa apparently being more susceptible to the acute effect than the bladder mucosa. Ordinarily the rectal irritation subsides after 2 or 3 weeks without further trouble. In some instances, however, the rectal irritation progresses to ulceration and infiltration with subsequent stricture formation.

In this case the rectal irritation persisted and after 3 months (in May 1932) there was definite ulceration. This gradually healed, but with evident beginning stricture from the scar tissue. This emphasizes the importance of investigation and treatment of any persisting rectal symptoms and also of rectal palpation in the check up examinations of these cancer patients. This patient had also a first degree X-ray infiltration of the skin of the abdominal wall (see under late X-ray effects).

BLADDER ULCERATION

CASE 1. B. H. aged 45 years. In June, 1925, received 3800 milligram hours of radium (in two treatments close together) for squamous cell carcinoma of cervix of clinical stage late II and also the regular deep X-ray therapy. Patient remained in good health for 3 years (until August, 1926) when she complained of bladder symptoms and the passing of bloody urine. Cystoscopic examination revealed a small ulcer in the bladder opposite the cervical region. This healed promptly under silver nitrate irrigations, and the bladder symptoms disappeared. There was no evidence of recurrence of the cancer. Subsequent check-up examinations showed no evidence of recurrence of the cancer and no bladder disturbance. In an examination in June 1930, the patient showed a marked hypertension, and in December she died of apoplexy. No autopsy was obtained.

CASE 2. E. P. aged 33. In September 1925, received 3000 milligram hours of radium for squamous cell carcinoma of cervix of clinical stage III. The patient received also deep X-ray therapy of which details will be given later as this is the patient with

sloughing of the skin mentioned under late X ray complications. In March 1928 this patient complained of bladder symptoms and on vaginal palpation there was a firm infiltration involving the bladder wall near the cervix. Cystoscopic examination showed just beyond the trigone an area of elevation varicosities submucous hemorrhage, and a small ulcer. It gave the impression of chronic inflammation rather than malignancy, and the subsequent course confirmed this diagnosis. This bladder disturbance cleared up under irrigations and instillations. The patient has been kept under observation, the last examination being in June 1934 and at no time has there been any evidence of the malignancy for which she received treatment in 1925.

CASE 3. R. H. aged 64 in June 1926 received 4000 milligram hours of radium for squamous cell carcinoma of cervix of clinical stage III and the usual deep X ray therapy. Patient remained well until January 1933 when she developed bladder distress and bloody urine. Cystoscopic examination showed an area of partial devitalization about 2 centimeters in diameter just above the level of the ureteral orifices. Surrounding the area were numerous dilated blood vessels radiating somewhat like the spokes of a wheel. Figure 1 (frontispiece) gives a very good representation of the cystoscopic appearance. The vessels bled easily when traumatized.

A small piece of tissue was removed from the area by Dr. J. R. Caulk, who had charge of the cystoscopic work in these cases. Microscopic investigation of the removed tissue showed chronic inflammation but no malignancy. Two fulguration treatments stopped the bleeding and the bladder irritability gradually lessened. In June, 1934 there had been no more bloody urine and the bladder symptoms were greatly improved.

CASE 4. A. S., aged 46 years, in August, 1929, received 3600 milligram hours of radium for adenocarcinoma of cervix of clinical stage III and the regular deep X ray therapy. The patient had also myoma of uterus and exophthalmic goiter and received medical treatment for the latter. The patient was in good health until July 1932 when she began to have bladder distress and passed bloody urine.

Cystoscopic examination revealed numerous dilated blood vessels in the portion of bladder opposite the cervix. Between the vessels, the bladder wall was pale and in the center was a grayish area. The entire field involved was about 3 by 4 centimeters, and it bled easily when touched. Scrapings removed through the cystoscope showed chronic inflammation but no malignancy. The bleeding was easily controlled by irrigations and instillations. Check up examinations in July and September 1933 showed absence of any further bleeding and not much bladder disturbance. At no time was there evidence of recurrence of the cancer for which treatment was given in 1929.

Of these 4 cases of late bladder complications the interval between irradiation treat-

ment and appearance of bladder trouble was 3 years 2½ years, 6 years and 3 years, respectively. The bladder symptoms developed rather suddenly and were soon followed by bloody urine. Cystoscopic examination showed a fairly uniform picture consisting of a devitalized area or ulcer with radiating dilated blood vessels (Fig. 1 frontispiece). The area bled easily when traumatized. Specimens removed through the cystoscope showed chronic inflammation without malignancy. In these particular cases the subsequent history showed the absence of accompanying malignancy, though such a non malignant lesion might occur in a case showing recurrent cancer activity either at that time or later. The lesion and resulting bladder symptoms yielded fairly well to irrigations and instillations fulguration to stop bleeding being required in only one case.

SLoughing OF SKIN

Pigmentation of the skin is of course to be expected over portals of entry for therapeutic roentgenization and is not counted of pathological significance. The late complication here referred to is a marked subcutaneous infiltration which caused thickening and irregularity of the skin and was later followed by sloughing.

CASE E. P. aged 33 years. In September 1925 received 3000 milligram hours of radium for squamous cell carcinoma of cervix of clinical stage III, and also deep X ray therapy. The X ray therapy was given in treatments on September 9 1925 November 4 1925 January 18 1926 March 23 1926 May 7 1926 July 15 1926 and November 26 1926. Each dose (given in two areas—one front and one back), milliamperes 30 time, 13 minutes kilovolts 200 filter 1 millimeter copper 1 millimeter aluminum portal 20 centimeters distance 50 centimeters.

Check up examinations from time to time showed the pelvis clear of evidence of recurrence of the cancer. As early as the latter part of 1926 it was noticed that there was an infiltration of the skin over an area of about 6 by 7 centimeters on the lower abdomen just above the symphysis pubis. Besides being highly pigmented, the skin was somewhat oedematous, with a deep firm infiltration. There was a smaller area presenting similar characteristics posteriorly over the sacrum. In October 1927 the subcutaneous infiltration had increased and definite telangiectasis was appearing in the areas. Figure 2 (frontispiece) gives a very good idea of the condition of the abdominal wall at this time. In March 1928

the patient developed an ulcer of the bladder which is reported as Case 2 under bladder ulceration. This yielded to treatment as previously mentioned. The abdominal wall infiltration showed increasing telangiectasis and serious local irritation. Figure 3 (frontispiece) shows the condition of the abdominal wall at this time.

The patient disappeared and did not return until October 1932. As the reason for not returning, she stated the skin of the lower abdomen sloughed away keeping her in bed for a period of 18 months. Apparently an area about the size of the hand in the involved region of the lower abdomen had necrosed. The necrosed skin had sloughed away to the subcutaneous tissue, leaving a large granulating surface. The patient was very stout with overhanging abdominal wall, and the granulating surfaces, being approximated, had healed together. At the visit in October 1932 the process of healing was only partly completed. There was still a small granulating area in the right side, and the healed area was tender. On her return, September 11, 1933, the abdomen was entirely healed. The line of scar tissue is shown in the photograph in Figure 4. In the right side of the scar there was an infiltrated area forming a small nodule. This was excised for microscopic investigation and showed chronic inflammation without malignancy. Over the scar area there was much infiltration and vascularization, but no sloughing. The photograph in Figure 5 is to show this area of discoloration. Naturally we have been watching the abdominal surface for malignant change, but so far none has appeared. At the last examination in June 1934, the patient was in good general health, and up and about her work without serious discomfort. At no time has there been any evidence of recurrence of the cancer for which she received treatment in 1925.

As to the etiology of this complication—why it appears in an occasional individual and not in others—the idiosyncrasies of the patient with the special reactions of her skin and subcutaneous tissues and blood and lymph must be taken into consideration. It is to be hoped that the study of this and allied conditions will develop some method of spotting those individuals with handicaps which limit their capacity to stand deep roentgenization.

In the course of check up examinations we have noted two lesser grades of what appears to be the same process. One case showed a very mild change in the skin and subcutaneous tissue.

This patient, aged 45, was given radium and deep X-ray therapy in February 1932. She developed a marked proctitis with some ulceration and later a rectal stricture, which is reported as Case 5 under

rectal strictures. The X-ray therapy consisted of 1030 r to lower abdomen on February 16, 1932, and 850 r to lower back on February 17, 1932. May 19, 1933, the patient complained of pain in the lower abdomen and vulva and thighs. Examination showed the abdomen markedly pigmented below the umbilicus with absence of pubic hair. No special vascularity was seen. There was some deep infiltration, causing thickening and irregularity of the skin. In June, 1934, the condition remained about the same.

Another case showed what may be designated as the second stage of the process, in which there was obvious vascular change in the form of telangiectasis.

This patient, aged 46 years, received radium and X-ray therapy in October 1930. She developed a mild rectal stricture, and is reported as Case 3 under rectal strictures. The X-ray therapy consisted of 900 r to lower abdomen on September 30, 1930, and 1000 r to lower back on October 1, 1930.

In the examination in June, 1932, it was noted that there was chronic infiltration of the abdominal wall with some superficial vascularity. By December 1932, the condition of the wall was definitely worse, the skin being raised in parallel ridges. In September 1933, the process showed no further progress, giving the impression that it had reached its maximum. June, 1934, the telangiectasis was more marked, pain in the abdominal wall was increasing, and the condition was becoming definitely worse.

GENERAL PLAN OF IRRADIATION TREATMENT

In order to improve the follow up in our cancer cases and better co-ordinate the work of the various services required in their treatment, we established some years ago a gynecological cancer clinic. This clinic is held every Tuesday afternoon and all cancer cases of the general gynecological clinic are referred to it. A special history is made in each case and a careful description of the growth recorded. The clinical classification of the cancer is made as far as conditions will permit, placing it in stage I, II, III, or IV of the League of Nations International Classification. A specimen is taken and sent to the laboratory for microscopic investigation and a bacterial culture also is taken from the growth as a control in clearing up the pyogenic infection which is usually present. Antiseptic douches are begun to be continued while the special treatment for the cancer is being carried out. The patient is immediately turned over to the

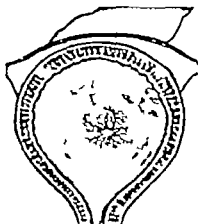


FIG. 1. Lat devitalization ulcer of bladder appearing 6 y. after irradiation treatment of carcinoma of cervix. The grayish appearance with numerous dilated blood vessels radiating toward the center is typical of this lat devitalization lesion. It is located opposite the cervix region, may appear from several years after the irradiation, and yields readily to treatment.

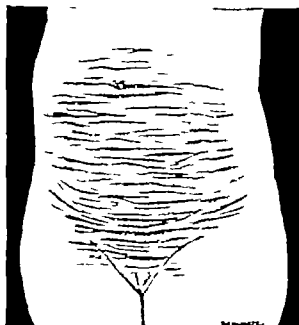


FIG. 2. Late subcutaneous infiltration of abdominal wall, appearing 2 years after irradiation treatment of carcinoma of cervix. Third degree, with deep extensive infiltration and marked widespread vascularization of the surface.



FIG. 3. The same abdomen as shown in Figure 2, but 3 months later. The devitalization had definitely progressed, and there was a small bluish area which appeared to be beginning necrosis.

Late Complications in Irradiation Treatment of Cancer of Cervix.
—Quinn J. Neuell and Harry S. Crossen.



Fig 4. Photograph of the same abdomen shown in Figure 3 (frontispiece) but 5 years later. An area the size of a hand had sloughed to the subcutaneous tissue. The granulating surfaces of the lax wall had fallen together and united. Microscopic examination of a section removed from the suspicious area on the right side showed no malignancy.



Fig 5. Same patient as in Figure 4. Back view to show the discoloration of the skin over the sacral area, where there was much infiltration and vascularization but no sloughing.

social worker and it should be emphasized that a good social worker is very important. She sees these ward patients in the clinic and hospital and, after dismissal from the hospital, sees that they return to the cancer clinic at the appointed time. She makes all appointments for X ray treatments with the Department of Radiology. The Department of Radiology has full charge of the deep X ray therapy, and works in close co-operation with the gynecologist. The gynecologist has full charge of the radium treatment and makes all radium implantations.

The systematic course of irradiation extends over a period of about 3 months. It is usually started with deep X ray therapy in order to secure some devitalizing effect on the outlying cancer cells before the stir up of the radium implantation in the center of the mass. This preliminary X ray therapy and course of local antiseptic treatment before the radium implantation is especially important where there is associated infection, as there usually is with ulceration or papillary formation. Two or 3 weeks after the preliminary roentgenization, the patient is hospitalized for the radium treatment.

After accurate implantation of the radium the bladder and rectum are pushed away by a

very firm packing in order to permit the maximum radium dosage which can be safely given with the conditions present in that pelvis. The packing is so firm that the patient can not urinate and on this account and also to keep the bladder empty and away from the radium, a retained catheter is used. The maximum dosage which can be given safely depends largely on how far away the bladder and rectum can be pushed by the packing. This depends on the amount of fixation of these structures by the carcinomatous infiltration and of course varies in each case. As a rule the infiltration is mainly into the lateral parametral tissues, with only late involvement of the bladder and rectal walls. At the time of the radium implantation, a careful examination under analgesia is made and a definite decision reached and recorded as to the clinical classification of the case. It is well also to make another bacterial culture at this time. For the radium treatment the patient ordinarily remains in the hospital about 5 days and after discharge returns to the clinic for check up examinations. About 8 weeks after the radium treatment the patient is given the second series of deep X ray.

This 3 months course of treatment comprises the regular course. Additional X ray or radium treatment is given only on special indication. After the 3 months course the patient returns for check up examination.

about every 2 months the first and second years every 3 months the third year every 4 months the fourth year every 6 months the fifth year and once a year after that. Of course if there is any local disturbance between times the patient is to come at once.

CONCLUSIONS

In the intensive irradiation treatment of 371 patients with carcinoma of the cervix most of them advanced we have encountered the following late complications:

Rectal stricture 5 cases mostly mild and all yielding satisfactorily to dilatation treatment.

Bladder ulceration 4 cases all responding to irrigations and instillations and only 1 requiring fulguration to stop bleeding.

Sloughing of the skin 1 case of extensive sloughing with subsequent healing. There was also 1 case of subcutaneous infiltration (first

degree) which seemed stationary and 1 case of subcutaneous infiltration with superficial vascular change (second degree) which was definitely progressive.

Of course some mild rectal strictures and lesser grades of subcutaneous infiltration may have escaped observation but the more serious lesions are not likely to be missed. We feel that we have been very fortunate to have accomplished so much in this disease, with so few serious complications. This applies both to the radium and the X-ray therapy. The radiologist Dr. Sherwood Moore, has succeeded in giving massive doses of X-ray which aided materially in curing patients and in giving temporary relief to others, with very few of the serious late effects. However we are always seeking improvements, and one of the problems of the day is the difficult task of diminishing still further the incidence of such complications.

THE CAUSE OF DEATH DUE TO LIVER AUTOLYSIS¹

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CONSIDERABLE confusion has developed in an attempt to explain the cause of death when liver tissue is found free within the abdomen. The observations presented by the various studies on this subject are often quite contradictory, however, the several authors state that one of the three following factors is the cause of death (1) a toxic substance generated in the autolyzing liver (4, 5, 6, 1), (2) the presence of bacilli resembling the *Bacillus welchii* (3) (3) anhydremia due to the loss of fluid into the abdominal cavity (7).

We have continued our studies in order to determine if the type of diet could in any way modify our previous results. While these studies were being conducted we have been making additional observations which we believe furnish a satisfactory explanation for the cause of death.

THE EFFECT OF HERBIVOROUS DIET

Rabbit 1 Female weight 8.25 pounds Nembutal anesthesia 1.6 cubic centimeters (1 grain per cubic centimeter) intraperitoneally supplemented with ether October 23 8.40 p.m. under aseptic precautions 16.5 grams of liver was removed from a second rabbit and placed high in the abdominal cavity. October 24 animal had quiet day. Water consumption in 24 hours was 500 cubic centimeters. October 25 8.30 a.m. animal was very active and alert. November 6 (14 days after operation) weight 8.25 pounds. The rabbit was killed and postmortem examination was made.

Rabbit 2 Female, weight 7.25 pounds. The procedure the same as for rabbit 1 was used. October 27 30 grams of liver including the gall bladder placed in the abdominal cavity. October 28 animal quiet but alert. October 29 animal was alert and active. November 6 10 days after operation, animal weighed 6.75 pounds. It was killed and a postmortem examination was made.

Rabbit 3 Male, weight 7.75 pounds. Same procedure as in previous experiments was used. November 4, 42 grams of liver was placed in the abdominal cavity. November 6 animal was alert, active and taking food and water. November 6 56 hours after operation, animal weighed 7.5 pounds. It was killed and postmortem examination was made.

The results of these experiments do not agree with the findings of Andrews and Hdrna (1) who state "The influence of diet was then studied by using herbivorous animals and the liver of 1 rabbit was planted into 5 other rabbits and exactly the same clinical picture of autolytic peritonitis was produced."

Dog 1 Female, weight 24 pounds. Preliminary preparation consisted in a high carbohydrate, low protein diet for 3 weeks. At 8.00 p.m. nembutal 3.4 cubic centimeters (1 grain per cubic centimeter) was given. At 8.45 p.m. this was supplemented with ether, and 30.5 grams of liver was removed and placed high in the abdominal cavity. At 10.00 p.m., the condition was good. At 7.45 a.m., the animal was dead, 10 hours after operation.

Dog 2 Female. High carbohydrate low protein diet was given for 5 weeks and 3 days. At 9.30 p.m. ether anesthesia was administered, and 46.75 grams of liver was sectioned and placed in the abdomen. At 10.00 p.m., the dog was in good condition. At 11.10 a.m. the animal was dead 13 hours, 40 minutes after operation.

These two dogs fed on a high carbohydrate diet showed no additional resistance, they lived only 10 hours and 13 hours 40 minutes respectively, following the operation. These are probably the most sudden deaths we have recorded.

THE EFFECT OF DOG LIVER IN RABBITS AND RABBIT LIVER IN DOGS

Confronted with the fact that rabbits survived the operation while dogs on a similar diet did not we next attempted to learn if the rabbits resistance was due to the increased resistance of their intact liver or due to the fact that the sectioned liver did not yield such toxic substances.

Rabbit 4 Weight 6.25 pounds. Nembutal and ether anesthesia was used. At 10.40 a.m. 3 grams of dog liver was removed while the animal was alive and placed in the abdomen of the rabbit. At 11.00 p.m. animal was alive but not in good condition. It was found dead the next morning.

Rabbit 5 Weight 7.75 pounds. Same anesthesia as for rabbit 4 was used. At 10.00 a.m. 21 grams of fresh dog liver was placed into the abdomen. At 5.15 p.m. breathing was labored and rabbit was

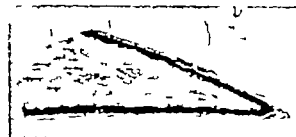


Fig. 1 Rabbit liver tissue undergoing aseptic autolysis

very listless. It was found dead the next morning.

Rabbit 6 Weight 8.25 pounds. The same anesthesia was used as in previous experiments. At 10:35 a.m. 30 grams of fresh dog liver was placed in the abdomen. At 5:15 p.m. the rabbit was alert and appeared well. It was found dead the next morning.

Rabbit 7 Weight 8.25 pounds. The same anesthesia as formerly was used. At 10:15 a.m., 18.25 grams of fresh dog liver was placed in the abdomen. At 1:15 the animal was sitting up and was alert. At 5:15 p.m. animal was apparently well. It was found dead the next morning.

Dog 5 Male Weight 33 pounds. Nembutal and ether anesthesia was used. At 7:30 p.m. 73 grams of liver was removed from a rabbit while it was alive and placed into the abdomen of the dog. At 8:45 a.m. the dog was standing. It drank much fluid during the day, the intake being approximately 1210 cubic centimeters above the output. At 7:00 a.m. (second day) the dog was found dead. Death occurred about 30 hours after operation. At 9:30 a.m. postmortem examination revealed the usual findings with 300 cubic centimeters of fluid in the abdominal cavity.

THE RELATIVE TOXICITY OF IMPLANTED CENTRAL AND PERIPHERAL LIVER TISSUE

Desiring to obtain additional support for our original observation in which we found that rabbits survived the operation we extended our series to include 3 more rabbits. However, in order to use fewer animals we removed the entire liver of 1 rabbit and divided it into three approximately equal portions. One piece was then placed into the abdomen of each of 3 animals with the following results.

Rabbit 8 Weight 8.25 pounds. At 10:30 a.m. 37.5 grams of liver was inserted. At 7:50 a.m. the next day the animal died.

Rabbit 9 Weight 6 pounds. The animal died the morning after 38 grams of liver had been inserted.

Rabbit 10 Weight 7.25 pounds. The animal died the morning after 41.5 grams of liver had been inserted.



Fig. 2 Rabbit liver tissue undergoing aseptic autolysis. Greater magnification than used in Figure 1.

These findings are contrary to our original observation and therefore agree with those reported by Andrews and Hrdina (1). It will also be noted that our technique in this series of rabbits was the same as that employed by Andrews and Hrdina, that is, introducing the entire liver of one animal into the abdomen of several other animals. Analysis of these results suggested to us that the only difference in the procedure used in the surviving animals and those that died, was the difference in the location from which the implanted liver was selected. In the former animals we introduced liver sectioned from the periphery while in the latter the sectioned liver included the central portion.

The following experiment illustrates the fact that implanted liver taken from the peripheral portion is less toxic than that taken from the central portion.

Rabbit 11 Weight 8.25 pounds. At 8:15 p.m., 15.9 grams of liver (peripheral portion) removed from a second rabbit and implanted. At 11:00, noon, the following day, rabbit was quite active and remained in good condition. It was killed 67 hours following operation and postmortem examination was made.

Rabbit 12 Weight 7.25 pounds. At 8:30 p.m., 15.9 grams of liver (central portion) was removed

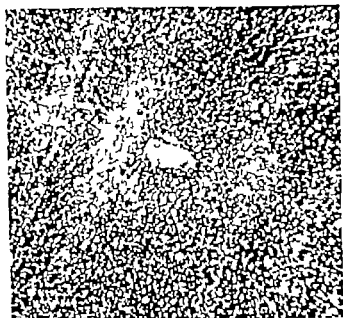


Fig. 3a. The host's liver (rabbit) accompanying the presence of aseptic autolysis.

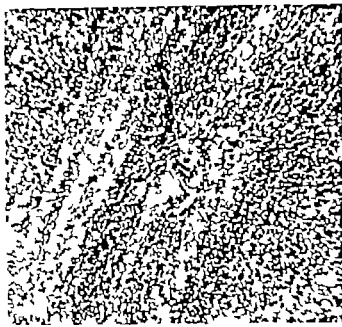


Fig. 3b. The host's liver (rabbit) accompanying aseptic autolysis.

from a second rabbit and implanted. At 8:15 a.m. the following day condition was good. At 10:30 a.m. animal died suddenly. Condition appeared good 10 minutes before death. Postmortem examination was made.

A STUDY OF THE HISTOLOGICAL AND BACTERIOLOGICAL CHANGES

The animals which survived the operation, that is those which received peripheral liver tissue were subsequently killed and an autopsy performed. The examination revealed a postmortem condition quite different from that which we have previously found (4) in the non-surviving animals. The implanted liver is firmly adherent to a loop of bowel. It is creamy-green in color, contains no gas and no odor. Occasionally, there is present only a small amount of free fluid in the peritoneal cavity. The sectioned liver shows a marked loss of weight ranging from 24 to 54 per cent in 10 days and 14 days respectively. This loss of weight is the result of phagocytic action and is well illustrated in the microscopic sections.

Figure 1 is an enlarged photograph of a paraffin section of liver tissue undergoing aseptic autolysis. It will be noted that the invading phagocytic cells are arranged in a dense formation producing a definite line below the liver capsule.

Figure 2 is a photomicrograph of the section in Figure 1 and shows the process more in detail.

While the autolysis illustrated is taking place in the implanted liver, the host's organs are also definitely damaged. Accompanying such damage the animals showed definite toxic symptoms.

Sections of the host's liver and kidney are presented in Figures 3a and b and Figure 4. Dr. L. A. Turley of the Department of Pathology gives the following description of the liver and kidney. This description is confined to tissue obtained by killing the rabbits ten days postoperative.

Liver "Cords of central and middle zones of the lobules show rarefaction so marked that the nuclei of the cells appear to be held in place by a lace like web. The cells of the peripheral zones have a fine, foamy appearance. The tissues of the portal canals are infiltrated with lymphocytes, endothelial cells and an occasional polymorphonuclear leucocyte. This infiltration is most marked around the bile ducts. This liver is the victim of what appears to be a rather acute and marked fatty degeneration plus a septic cholangitis."

Kidney "The lesions in the kidney vary with the different fields. In some fields the capillaries of the tufts and tubules are en-

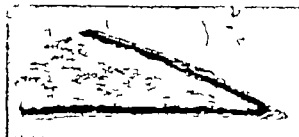


Fig. 1. Rabbit liver tissue undergoing aseptic autolysis

very listless. It was found dead the next morning.

Rabbit 6 Weight 8.25 pounds. The same anesthesia was used as in previous experiments. At 10:25 a.m. 20 grams of fresh dog liver was placed in the abdomen. At 5:15 p.m. the rabbit was alert and appeared well. It was found dead the next morning.

Rabbit 7 Weight 8.25 pounds. The same anesthesia as formerly was used. At 10:15 a.m. 18.25 grams of fresh dog liver was placed in the abdomen. At 1:15 the animal was sitting up and was alert. At 5:15 p.m. animal was apparently well. It was found dead the next morning.

Dog 3 Male Weight 33 pounds. Nembutal and ether anesthesia was used. At 7:30 p.m. 73 grams of liver was removed from a rabbit while it was alive and placed into the abdomen of the dog. At 8:45 a.m. the dog was standing. It drank much fluid during the day, the intake being approximately 120 cubic centimeters above the output. At 7:00 a.m. (second day) the dog was found dead. Death occurred about 30 hours after operation. At 9:30 a.m. postmortem examination revealed the usual findings with 300 cubic centimeters of fluid in the abdominal cavity.

THE RELATIVE TOXICITY OF IMPLANTED CENTRAL AND PERIPHERAL LIVER TISSUE

Desiring to obtain additional support for our original observation in which we found that rabbits survived the operation we extended our series to include 3 more rabbits. However in order to use fewer animals we removed the entire liver of 1 rabbit and divided it into three approximately equal portions. One piece was then placed into the abdomen of each of 3 animals with the following results.

Rabbit 8 Weight 8.25 pounds. At 10:30 a.m. 37.5 grams of liver was inserted. At 7:50 a.m. the next day the animal died.

Rabbit 9 Weight 6 pounds. The animal died the morning after 38 grams of liver had been inserted.

Rabbit 10 Weight 7.25 pounds. The animal died the morning after 41.5 grams of liver had been inserted.



Fig. 2. Rabbit liver tissue undergoing aseptic autolysis. Greater magnification than used in Figure 1.

These findings are contrary to our original observation and therefore agree with those reported by Andrews and Hrdina (1). It will also be noted that our technique in this series of rabbits was the same as that employed by Andrews and Hrdina, that is, introducing the entire liver of one animal into the abdomen of several other animals. Analysis of these results suggested to us that the only difference in the procedure used in the surviving animals and those that died was the difference in the location from which the implanted liver was selected. In the former animals we introduced liver sectioned from the periphery while in the latter the sectioned liver included the central portion.

The following experiment illustrates the fact that implanted liver taken from the peripheral portion is less toxic than that taken from the central portion.

Rabbit 11 Weight 8.25 pounds. At 8:15 p.m. 150 grams of liver (peripheral portion) removed from a second rabbit and implanted. At 12:00 noon, the following day rabbit was quite active and remained in good condition. It was killed 67 hours following operation and postmortem examination was made.

Rabbit 12 Weight 7.25 pounds. At 8:30 p.m. 150 grams of liver (central portion) was removed



Fig. 6 Organism obtained from central portion of rabbit liver

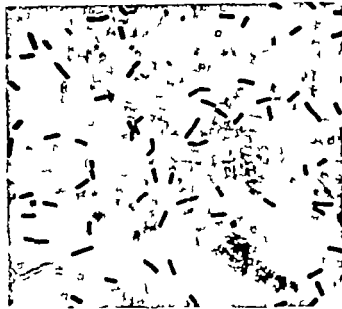


Fig. 7 Impression smear of the liver from incubated rabbit 13

into each of rabbits 13 and 14. After 5 minutes rabbit 13 was killed and placed in an incubator for 22 hours. Autopsy at this time showed the following. The liver was soft and friable with a consistency that of soft cottage cheese. All the tissues were crepitant. The striated muscle was riddled and the odor was very foul. Impression smears were made and stained by the Gram's method which showed enormous numbers of positive rods identical with those found in the autolyzed liver of rabbit 12.

Rabbit 14 Was permitted to live and showed no ill effects from the injection.

Figure 6 is a photomicrograph of the organism which was obtained from the culture of the central portion of liver, part of which was implanted in rabbit 12. The peripheral portion of the same liver and that which was introduced into rabbit 11 on culture showed no anaerobic organisms.

Figure 7 was obtained as an impression smear from rabbit 13. The source of the organism was the same as that reported in Figure 6.

DEDUCTIONS

Sectioned liver tissue undergoing aseptic autolysis within the abdomen is accompanied by definite damage to the host. This is evidenced by changes in liver and kidney of host and also by toxic symptoms manifested.

In all of our previous reports on this subject, the experimental data were obtained from dogs. Therefore when the first 3 rabbits of this series survived the operation we were of

the opinion that the survival was due to the type of diet selected by the rabbit. This conclusion also agreed with the observation of Salzmann who found that rats either survived the operation or died depending entirely upon the type of diet fed the animals.

Continuing our experiments we have been forced to conclude that all the surviving animals received implanted liver tissue sectioned from the periphery of the liver. Such tissue proved to be free of the anaerobic bacillus. We further observed that the implanted liver tissue sectioned from the central portion caused death and also gave a positive culture for the organism. It has been observed by Andrews et al. (1) and also by Dvorak that this organism may be injected in large amounts into the peritoneal cavity without causing the death of the animal. We have injected the organism intravenously and found it affected the animals but little if at all. However if shortly after such an injection we killed and incubated the animal we subsequently found the tissues completely riddled by the organism, the liver being destroyed.

The sequence of events which leads to the death of the animals appears to be as follows. The bacteria remain in a latent state until stimulated to activity by the asphyxiation of the liver tissue. The activity of the bacteria then accelerates the production of toxic prod-

ucts and these in turn cause death by producing a chemical reaction. The picture is not that which we usually consider as a generalized peritonitis but the bacteria confine their activity locally to the selected substrate. Also the rapidity with which death follows the operation after 10 to 15 hours is not in keeping with the usual picture of peritonitis. The damage to the tissues of the host shown in the microscopic sections, with and without the presence of bacteria, rather suggests that the process which produces death is not necessarily a difference in kind but rather a difference in degree, the action of the bacteria only accelerating the liberation of toxins from the liver tissue. Trusler and Reeves have demonstrated the fact that the organism does not produce exotoxins and it has also been shown that the organism may be cultured within the abdomen, substrates other than adult liver tissue being used without causing death (3).

CONCLUSIONS

1. Additional evidence is submitted to support the contention that the absorption of dead and autolyzed tissue is associated with toxic symptoms on the part of the host.

2. Death is not due to a generalized peritonitis but rather to the absorption of toxic products generated from the liver tissue deprived of its circulation.

3. The anaerobic bacillus found at the time of death may be injected intraperitoneally and intravenously without causing any harmful results.

We wish to express our appreciation for the assistance given us by Miss Ida Lucille Brown of the Department of Bacteriology.

BIBLIOGRAPHY

1. ANDREWS, EDMUND, et al. Newer aspects of liver disease. *Surg. Gynec. & Obst.* 1928, 47: 177-182.
Idem. The cause of death in liver autolysis. *Ibid.* 1931, 53: 61-66.
Idem. Causation of Bacillus welchii infections in dogs by injection of sterile liver extract or bile salts. *Ibid.* 1931, 53: 176-181.
2. DYORAK, HAROLD J. Liver autolysis in the peritoneal cavity of the dog. *Proc. Soc. Exper. Biol. & Med.* 1931, 32, 29: 431-434.
3. ELLIS, J. C., and DRAOESTEDT, L. R. Liver autolysis in vivo. *Arch. Surg.* 1930, 20: 8-16.
4. MASON, E. C., DAVIDSON, E. C., MATTHEW, C. W., and RASTELLO, P. B. A study of tissue autolysis in vivo. I. Blood changes, physical and chemical. *J. Lab. & Clin. Med.* 1935, 10: 622-630.
5. MASON, E. C., DAVIDSON, E. C., and RASTELLO, P. B. A study of tissue autolysis in vivo. II. A pharmacological study of the toxic material. *J. Lab. & Clin. Med.* 1935, 10: 606-613.
6. MASON, E. C., and LINCOLN, C. W. Autointoxication and shock. *Surg. Gynec. & Obst.* 1931, 53: 60-64.
7. Idem. Anhydremia as a possible cause of death in liver autolysis. *Surg. Gynec. & Obst.* 1934, 55: 427-43.
8. SILEMAN, HARRY A. The cause of death in liver autolysis. *Beitr. z. klin. Chir.* 1932, 156: 77-84.
9. TRUSLER, HAROLD M., and REEVES, JAMES R. Significance of anaerobic organisms in peritonitis due to liver autolysis, bacterial flora of the liver and muscle of normal dogs. *Arch. Surg.* 1934, 58: 479-491.

THE HISTOLOGY OF THE BILIARY DUCTS AND ITS CORRELATION WITH THE SYMPTOMATOLOGY OF COMMON DUCT STONE¹

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STANDARD works of reference in medicine and surgery enumerate a remarkably uniform list of symptoms said to be caused by the presence of calculi in the extrahepatic biliary passages. In the past several years, the "asymptomatic common duct stone" has been the theme of several writers (3-6), but nevertheless the gathered opinions of members from several surgical staffs gave the impression that biliary colic is the chief signpost to a diagnosis of calculus in the common duct. In direct variance with this is a statement by Professor D. P. D. Wilkie of Edinburgh that common duct stone never gives rise to colic since that section of the biliary tract exhibits in its wall no muscular tissue, and is therefore non-contractile non-peristaltic. Attacks of biliary colic, Wilkie stated, are produced only by the passage of a stone along the cystic duct with its regular layers of musculature. This assertion seemed sufficiently novel to merit investigation, and if proved would obviously be of great diagnostic importance. The subject has been pursued along three lines:

1. Review of recent literature.
2. Study of the detailed histology of the bile ducts.
3. Analysis of case histories of patients proved to have had choledocholithiasis over a 5 year period at the Los Angeles County General Hospital and the Toronto General Hospital.

It will be shown that the correlation of anatomical findings with symptoms in these cases, with due reference to the duct histology outlined below, disprove practically all the commonly accepted explanations of pain production in biliary colic.

1. Much of the recent literature on the subject has been concerned with the absence of the classical signs and symptoms in many cases and the wide variance possible in the clinical picture. In 1877, Charcot first described the intermittent fever in common duct

obstruction which has since been associated with his name. Kehr in 1900 remarked that jaundice may be absent in common duct stone, and in Jordan's series of 106 operations for this condition 10.6 per cent of the patients were without jaundice. Oertel described a case in which complete common duct obstruction by stone had been compensated for by saccular dilatations of the ducts to such an extent that the patient died without jaundice. Mann's experiments verified this possibility in animals where dilatation of the ducts delayed the onset of jaundice. Clute reported that 31 per cent of his operative cases with common duct stone showed no jaundice. He recommended more frequent choledochotomy when operating for calculous cholecystic disease having found stones in the common duct in 18 per cent of his cases in a 3 year period due to this procedure. He remarked that a slight elevation of blood bilirubin often means common duct stone. A further series of cases reported by Klingenstein showed 6 per cent without jaundice and a slightly smaller percentage without colic.

The theories that have been advanced to account for causation of biliary colic are many and varied. Such are concerned with impaction of a calculus in the ampulla of Vater, distention of the ducts and the size and shape of the obstructing stone. The cases to be quoted below will suggest the futility of such explanations. Rolleston and McNee are authorities for the statement that severe biliary colic may be present in the absence of any calculi, being due to cholecystitis with inflammatory reaction in the sensitive sub-peritoneal tissues. Most commonly accepted is the view that colic is due to spasm of the ducts by their constituent muscular layers. With this in mind the investigation of the histology of the bile ducts was undertaken.

2. An amazing variance of ideas as to the normal histology of the bile ducts was encountered in the various standard works, old



Fig. Low power field from an area in a longitudinal section of the common bile duct, 2 millimeters distal to the sphincter of Oddi. Shows scattered muscle fibers, usually lying unidirectionally among fibrous and elastic tissue. At the lower edge are seen a few organized muscular strands tailing off from the sphincteric muscle. Phosphotungstic acid stain.

and recent. For example a large volume of *Special Cytology* published in 1928 (10) states that in the cystic duct exist three-directional smooth muscle fibers while in common and hepatic ducts only very small amounts are present and without definite layers. Max imow emphasizes the fact that only the common duct shows bundles of smooth muscle running in oblique and longitudinal directions, forming an incomplete layer around the duct. Burden observed that the hepatic, cystic, and common bile ducts are identical in structure there being bundles of unstripped muscle lying in the outer layer of areolar tissue together with blood vessels and lymphatics. He claimed that these muscle bundles were well developed and formed isolated longitudinal and circular layers thus producing a loose network rather than a compact layer. Rolleston and McNece make the bald statement that the bile ducts are without muscular tissue at any point but quote no proof of such statement. In spite of the fact that nearly all possible combinations seemed to have been exhausted by these various authorities, it was proposed to prove, if possible which of the statements here quoted was correct.

Microscopic sections were first made from the various parts of the bile duct—hepatic, cystic, and common. Three stains were employed: hematoxylin and eosin, phosphotungstic acid stain for muscle, and Weigert's for elastic tissue. As no muscular coats could be found in the bile ducts in the material examined from the first few autopsies, a more systematic method was followed.

The gall bladder and the cystic and common ducts down to the entrance of the latter into the duodenum and including a section of the duodenal wall were removed from cadavers showing no gross evidence of biliary tract infection. After being washed in water the preparation was injected through the ampulla of Vater with Zenker's solution until the ducts were moderately distended. When sufficiently fixed, sections were taken at regular levels, as follows:

- A Through sphincter of Oddi and along the terminal portion of the common duct
- B From proximal portion of common duct
- C From distal end of cystic duct
- D From proximal portion of cystic duct
- E Through the junction of cystic duct with the neck of the gall bladder

These sections were then stained with phosphotungstic acid which after study of numerous sections, was determined to be the best stain for the detection of muscle tissue. In all, 84 sections, some transverse but most of them longitudinal were prepared from the material obtained from 14 autopsies.

A study of these sections shows that the muscular coats, as such cease very abruptly at the neck of the gall bladder sometimes with a sphincter like structure at the origin of the cystic duct. The remainder of the biliary ducts—common, cystic, and hepatic, are merely fibro-elastic tubes, lined with a high columnar mucosa covered by a serosal layer with the usual subserosal areolar tissue. Only small isolated fibers of unstripped muscle are present sometimes indistinguishable from connective tissue cells. In many sections, a search of several high power fields is necessary to demonstrate even isolated muscle cells. A striking point in the study of many of these ducts is the presence of comparatively large glands in the duct walls, as described by Burden. It is a

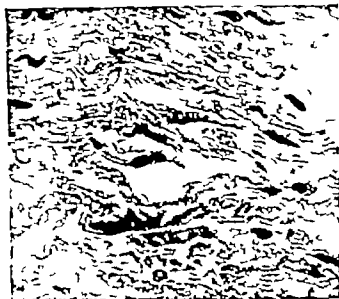


Fig. 2 High power view of a field from Figure 1. Individual muscle fibers stand out in contrast to connective tissue.

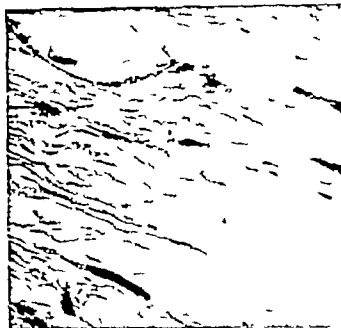


Fig. 3 High power view of an area several low power fields distal to that in Figure 1. Note marked decrease in number of muscle fibers. Phosphotungstic acid stain.

real possibility that these glands offer lodging to organisms metastatic from other foci of infection and subsequently become responsible for low grade cholangitis. Nerve fibers are present in great abundance, usually distributed in the outer part of the wall.

3 The clinical review was confined to those cases definitely proved to have had calculi in the common duct. This reduced the number of cases in the 5 year period to 16 at the Toronto General Hospital (1926-31) and 8 at the Los Angeles County General Hospital (1927-32) in which stone had actually been removed from the common duct at operation or autopsy. When contrasted with the figures from other surgical clinics (Mayo Clinic 106 in 10 years, Mayo-Robson 380 in 10 years) this seems to indicate an extraordinarily low incidence of calculous cholecystic disease among hospital populations of over 30,000 (T.G.H.) and 90,000 (L.A.C.G.H.). This variation is due in part of course to the greater number of elective cases in other clinics.

The histories were examined as to 6 cardinal points (1) chronic indigestion (i.e. painful digestion) flatulence and so called bilious attacks with headaches as elicited in the past history, (2) dull pain in upper abdomen with radiation posteriorly (3) well defined biliary colic, (4) presence of jaundice, (5) chills, (6) fever. The relative frequency of

these findings for the two series of cases is presented in Tables I and II. In Table III is shown the percentage incidence of these signs and symptoms in the combined series.

Certain points are of interest even in this small series. Jaundice is the one near constant sign, yet one woman with a 3 year history and as many calculi in the common duct failed to show an icteroid tinge at any time although the icteric index was 13.7. Next in order is a high percentage with history of digestive upset or chronic upper abdominal pain or both over a period of years or at least months. *There was frequently acute exacerbation of such symptoms when the calculi presumably entered the biliary ducts* as shown by 81 per cent of the quoted cases. Much of this is due of course, to activation of chronic cholecystic disease but a perusal of these clinical histories leads one to believe that any individual who suffers in mid or late life a sudden up-trend in severity of previous cholecystic symptoms is an eligible candidate for the diagnosis of common duct stone. If this be associated with icterus and its accompanying manifestations or failing that an elevated blood bilirubin or with a dull radiating upper abdominal pain or with chills or fever the diagnosis becomes more than probable.



Fig. 4. Low power view of an area from the mid portion of the common bile duct. Virtual absence of muscle fibers. Large groups of hyperplastic glands in duct wall, some of which are cystic and dilated. Hematoxylin-eosin stain.



Fig. 5. Low power photomicrograph of an area from the mid portion of a cystic duct. There is complete absence of muscle fibers. Phosphotungstic acid stain.

Most unusual in this series is the extraordinarily low incidence of biliary colic. With the appearance of colic the difficulties of diagnosis are largely erased, but 56 per cent of these cases failed to present such conclusive evidence of common duct stone. In none of the 8 autopsy cases in which the pathologist was the final arbiter was the symptom of colic found in the medical history. This is certain indication of the reluctance with which a diagnosis of biliary duct calculus is surveyed without the *sine qua non* of colic.

Chills were a feature in 7 instances (26 per cent) and fever in 8 (29 per cent).

It should be mentioned that the dull upper abdominal pain complained of by some of these patients is by no means confined to the right upper quadrant. At least 4 (14 per cent) reported left upper quadrant pain and 3 epigastric pain. Two of the former patients had their radiation of pain to the left scapula.

Only 1 of the 27 cases presented all of the 6 cardinal features herein tabulated and a second 5. Ten or 37 per cent had 4 out of the 6 signs or symptoms, and 6 (22 per cent) only 3. Seven others had only jaundice and one other point, while 1 case presented only jaundice. In the aged, common duct stone, like acute appendicitis, seems remarkable for the lack of clinical evidence produced. Especially is this true of the colic symptom only patient in this series over 60 presenting this evidence.

Clute's advice regarding more frequent opening of the common duct during operative

procedures for cholelithiasis seems to be borne out in this series. Nine of the quoted cases had had previous cholecystectomies or cholecystotomies and several operative reports stated the bile ducts to be without exterior evidence of calculi. In experienced hands the mortality cannot be appreciably raised by the additional technique and time involved. There is certainly adequate compensation, even if convalescence is lengthened by duct drainage in the knowledge of a certain result. The formation of calculi in the intrahepatic ducts, as described by Judd and Burden is of great rarity.

Certain cases of this series merit special remark inasmuch as they illustrate the futility of attempting any reasonable explanation of pain production.

M. C. female, 40 years old, suffering severe colic, was found at operation to have the largest solitary stone in the series, 3 by 2.5 centimeters, in the common duct. It has been said that small stones produce most severe colic. In this instance, at least, a large stone produced severe colic.

J. F., aged 57 years, had had a cholecystectomy in 1923 and was admitted in 1928 with jaundice, fever, and chills. He was without pain or colic, and the autopsy showed a calculus of bean size impacted in the ampulla of Vater and behind it several smaller stones. The ducts were distended to several times normal diameter throughout. In brief, this individual had failed to develop colic or pain in spite of impaction of a stone in the ampulla, the presence of several small stones, and distention of the ducts—all of which conditions have been named at one time or another as causative of colic.

TABLE I—PROVED COMMON DUCT STONE
Cases at Los Angeles County General Hospital, 1927-1933

Case	Age	Sex	C I	Radiation	Colic	Chills	Fever	Jaundice
M C 144 408	46	M	+	o	+	o	+	+
R C 47 776	90	F	+	+	+	+	+	+
W E R 152 81	64	M	+	o	o	o	+	+
E M 60 767	53	F	+	+	o	+	+	o
E I 178 350	44	F	+	+	+	+	+	+
J M 178 640	70	M	o	o	+	+	o	+
T B 5 941	37	F	+	+	+	+	+	+
I W 90 768	44	M	+	o	+	+	+	+
J M 124 7 2	60	M	+	+	+	+	o	+
J H 36 560	77	F	+	+	+	+	+	+
M N 10 722	53	F	+	+	o	+	o	o

Key C I—Chronic indigestion, flatulence etc.
Radiation—Dull pain with radiation

J E was a man of 70 years who had suffered from dull epigastric pain for 10 years, but never from colic. In hospital he had a moderate increase of the pain with intermittent chills, fever and jaundice. Autopsy showed a marble sized stone occluding the ampulla of Vater with several others in the duct. In the liver were multiple abscesses. Again no colic in spite of multiple stones and occlusion.

M D, a woman 70 years of age presented increasing jaundice for 5 months. After admission to hospital her empyemic gall bladder was drained. Autopsy proved the common duct to contain 13 stones of various size. All the hepatic ducts were dilated. She had never suffered even dull pain, nausea, vomiting, and headaches were the only symptoms. Here multiple stones and dilatation of even intrahepatic ducts failed to produce pain.

F C was a man of 70 years, whom autopsy showed to have a carcinoma of the gall bladder with complete occlusion of the cystic duct by carcinomatous invasion. He died with a deep jaundice of 5 months standing which was found at autopsy to be due to stone obstructing the common duct itself quite patent, and with the remainder of the biliary tree free from carcinomatous invasion. This stone must therefore have been present for many weeks in the common duct (i.e. before the cystic duct became occluded by carcinoma) and was probably responsible for the marked jaundice. His only pain had been epigastric and of very moderate severity generally following meals. Thus, in spite of a calculus obstructing the common duct for many weeks—probably 5 months—this individual had never exhibited anything approaching a colic like pain.

Illustrating the necessity of common duct exploration in doubtful instances is the case of W F R a 64 year old male.

TABLE II—PROVED COMMON DUCT STONE
Cases at Toronto General Hospital 1926-1931

Case	Age	Sex	C I	Radiation	Colic	Chills	Fever	Jaundice
E K 03500	66	F	+	+	+	o	o	+
J M 0 1671	53	M	+	+	+	+	+	+
E C 419 47	52	F	+	+	+	o	o	+
J M 057724	50	F	+	o	o	+	o	+
F B 027624	38	M	+	o	+	o	+	+
M C 024451	40	F	o	+	+	o	+	+
G M 043704	33	M	+	+	o	+	o	+
K M 057083	33	F	+	+	+	+	+	+
M C 030081	65	F	+	+	+	+	+	+
L K 040677	57	F	+	+	+	+	+	+
J F 12373	57	M	o	+	o	+	+	+
J E 2 308	70	M	+	o	+	+	+	+
M D 1 344	70	F	+	o	+	+	+	+
H R 019603	50	M	+	+	+	o	o	+
F C 04791	70	M	+	o	o	+	+	+
M T 05787	71	F	+	+	o	o	o	+

TABLE III

	Cases	Per cent
Total cases of common duct stone	7	
Female	15	55
Male	2	45
A. single stone	16	
Chronic indigestion, flatulence etc.	12	6
Dull pain with radiation	12	43
Biliary colic		44
Jaundice	3	93
Chills	1	26
Fever	1	20

Ten years before the last admission a cholecystectomy had been performed and this was followed by jaundice. During the following years he suffered from recurring indigestion and occasional dull epigastric pain. Before admission he developed a constant dull epigastric pain and pain in the right upper quadrant without radiation followed by a gradually developing jaundice. In hospital, a pre-operative diagnosis of catarrhal jaundice or adhesions was made and the occasional chills he complained of laid to hysteria. The jaundice cleared, the abdomen was opened, and gastro-enterostomy was done because of dense distorting adhesions about the pylorus. The biliary ducts were not explored. After a postoperative death an obstructing calculus was found at autopsy in the common bile duct.

The same point is illustrated by another case.

E. M., a 53 year old woman who 3 years before admission had been operated upon for empyema of the gall bladder. At that time a number of stones were

removed from the gall bladder and the gall bladder drained. She continued to have chronic right upper quadrant pain and flatulence for the 3 years, but no colic at any time. Eventually the common duct was explored and found to contain 3 large stones, and the duct itself was much thickened and dilated.

I. W. a male aged 70 years, illustrates the case with atypical distribution of pain. Having had a cholecystectomy 13 years previously his chief complaint on admission was left upper quadrant pain radiating to the left scapula. As he presented a marked jaundice and had constant chills and fever the common duct was explored and a solitary stone 3½ centimeter in diameter removed.

SUMMARY

1 Material has been examined to show that the biliary ducts possess throughout only small isolated fibers of muscle irregularly scattered. The bile ducts are fibro-elastic tubes, richly supplied with nerve fibers, lined by tall columnar epithelium and frequently featured by the presence of large subepithelial glands lying in the membrana propria singly and in groups.

2 Biliary colic is not caused by muscular spasm according to these histological findings. Several quoted cases go to show that most of the other theories usually advanced as etiological factors of pain are probably false.

3 Colic is by no means a constant symptom of calculi in the bile passages, as shown

by an absence of that symptom in 56 per cent of 27 cases presented.

4 The most frequent symptom of common duct stone is an exacerbation of previous indigestion flatulence or dull upper abdominal pain with or without radiation. The one near constant finding is jaundice.

5 A survey of this series impresses one with the need of more frequent exploration of the common duct as a combined procedure with cholecystectomy for cholelithiasis.

BIBLIOGRAPHY

- 1 BURDEN, V. G. Observations on the histologic and pathologic anatomy of the hepatic, cystic, and common bile ducts. *Ann Surg.* 1925, 81: 584-607.
- 2 CHANCOT, JEAN MARTEL. *Leçons sur les maladies du foie*, etc. Bureau de prog. m'd. Par. 1877.
- 3 CLUTE, H. M. *Surg. Clin. N. America*, 1931, 2 No. 2.
- 4 JORDAN, F. M. *Proc. Staff Meet. Mayo Clinic*, 1930, 5: 56-57.
- 5 KRELL, H. *Gallstone Disease*. Translated by N. W. Seymour. Philadelphia: P. Blakiston's Son & Co.
- 6 KIDGERSHIRE, FRANK. *Ann. Surg.* 1931, 93: 1146-1150.
- 7 MAYNOR, A. A. *Text Book of Histology*. Philadelphia: W. B. Saunders Co. 1930.
- 8 ORTELL, H. *Arch. Int. Med.* 1918, 2: 73.
- 9 ROLLISTON and McVIE. *Diseases of the Liver, Gall Bladder and Bile Ducts*. New York: The Macmillan Co. 1929.
10. *Special Cytology*. New York: Paul B. Hoeber Inc. 1928.
11. WELKE, D. P. D. Personal communication to Prof. W. F. Gallie.

THE BLEEDING TENDENCY IN JAUNDICE¹

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THE surgical and medical risks of infections and other pathological processes in and about the liver are seriously augmented by the possibility of hepatic insufficiency. One of the most striking surgical features associated with these cases of liver damage is their tendency to bleed. According to the results obtained in several clinics 50 per cent of all postoperative deaths in patients with jaundice or liver insufficiency are a result of hemorrhage (8, 25, 26, 36). The following study was undertaken chiefly in an effort to reduce these operative risks.

DETERMINATION OF BLEEDING TENDENCY

The first objective was to devise a reliable clinical method that would disclose the latent hemorrhagic tendency in jaundiced patients. The great variability of bleeding tendency in jaundice is well known. Jaundiced patients with a normal Duke's bleeding time, normal coagulation time and normal blood coagulating factors will frequently bleed abnormally and patients with abnormal findings will frequently not bleed. Many clinical and laboratory methods have been recommended to determine the existence of a bleeding tendency but none of them so far has been an accurate guide. As Colbeck has stated there is no definite method as yet for the evaluation of the bleeding tendency in jaundice.

1. *Blood coagulation factors.* *In vitro* studies of the various blood coagulation factors in jaundice have been extensive. Analysis of the literature forces the conclusion that although there are variations in these factors these variations cannot be correlated reliably with the bleeding tendency. Changes in blood calcium, fibrinogen, platelets, prothrombin, antithrombin, sedimentation rate, etc. are observed just as frequently without as with a hemorrhagic diathesis in jaundice.

a. *Calcium.* There is undoubtedly a disturbed calcium metabolism in jaundice such as altered calcium balance, osteoporosis, etc.

As one of us (A. C. I. 14) has already pointed out, the literature does not agree on the relation between this disturbance of calcium and the hemorrhagic diathesis found in some cases. Blood calcium levels both fixed and diffusible are unchanged or only slightly changed in jaundice. The general weight of experimental evidence seems to uphold the view that although a functional deficiency of calcium exists, it has no relation to the bleeding tendency (Linton, 22; Snell and Greene, Gunther and Greenberg, Ivy, Wangensteen, Colbeck).

It is true that in jaundice intravenous calcium improves coagulation *in vitro* but the mechanism by which it does so is not clear. Furthermore, extravascular clotting has little relation to bleeding tendency. Following the lead of Mayo-Robson, Wright and Paramore, Lee and Vincent, Walters (34), Whipple, Judd and others, the pre-operative administration of calcium is widely used (Cantarow, McKnight, Webb, Brennan, Hanlon, Sistrunk and others). But failures are frequent. As Wangensteen and also Colbeck have summed up, intravenous calcium has not solved the problem of hemorrhage in jaundice.

Blood calcium determinations therefore are of no value in determining the bleeding tendency. The problem of diffusible calcium presented itself however and was studied in many of our cases. The results will be set forth in a separate communication.

b. *Other blood coagulation factors.* Bancroft, Kugelmass and Stanley Brown in a study of 200 surgical cases concluded that no one factor can be isolated as a cause of bleeding or clotting. They devised a "clotting index" calculated from a composite of the determinations of the prothrombin content, fibrinogen content, platelet count, degree of platelet lysis and antithrombin. In later studies they dropped the platelet count and lysis studies, because these could not be correlated with clinical bleeding. Another inter-

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esting conclusion was that the clotting tendency can be determined reliably after operation but not before, because when a bleeding tendency exists, the ether damage to the liver and operative shock make it manifest the liver and operative shock make it manifest.

For clinical use such a clotting index is entirely too elaborate (Mills, and Clute and Veal). But of greater importance it is probably inaccurate. The attempt to study the bleeding tendency by splitting it into many factors is misleading. One factor after another is heralded as the important one only to be dropped when found to be clinically unreliable. For in any given case one factor may compensate for another both in the calculation and clinically. In different bleeding conditions, different factors are involved. Furthermore, when all factors are normal the patient may still bleed because he may be on the threshold of bleeding and ether acidosis, operative shock etc may push him over this threshold. It seems as if the only way at present to determine a bleeding tendency is to see if the patient bleeds. Yet such a posteriori determinations would be of no value in preparing patients for operation.

With particular reference to jaundice the same conclusions apply. Lewisohn found a decrease in prothrombin and fibrinogen and an increase in antiprothrombin associated with increased risk of hemorrhage. Murakami and Yamaguchi found a decrease in fibrin ferment in jaundice. Johnson concluded that in experimental obstructive jaundice clotting was delayed because the quantity and quality of the fibrin seems deficient. But Linton found that in obstructive jaundice there is no deficiency in the blood fibrin in fact a distinct increase. Moss also found a distinct obstructive jaundice. Mann and Bollman found in plasma fibrinogen in experimental obstructive jaundice. Mann and Bollman found after removal of the liver that prothrombin did not change, antithrombin sometimes increased and sometimes decreased and fibrinogen remained normal for a time but after depletion did not regenerate. The sedimentation rate has also been suggested as a guide to the bleeding tendency in jaundice. Linton (21) considers it to be an accurate guide. Clute and Veal however consider it suggestive and helpful but not absolute.

As with calcium after much study determinations of other blood clotting factors were discarded in the present study as not furnishing a reliable guide.

2. Coagulation time. Determination of coagulation time is today a most widely used procedure. Yet it seems to have relatively little value. In many hundreds of cases studied by many authors (Kleinert, Hunt, Harter, Feinberg, Bland and Stanley Brown, Kugelmass, Bancroft and Stanley Brown, and others) the general conclusions are that prolonged clotting time seems to bear no relation to clinical dyscrasias and when normal in severe blood dyscrasias and bleeding occurs. The only condition in which a prolonged coagulation time is diagnostic is hemophilia. The multiplicity of methods devised for the determination of clotting time points to the difficulty in their evaluation. No less than 33 different methods (probably more) are known (Solis-Cohen). Moreover the numerous factors affecting the clotting time of shed blood such as contact with air, glass, and dirt, size and shape of drop amount of blood, mechanical disturbance and point of evaporation, temperature, dilution, meteorological factors, age, hemoglobin, food, fluid, contact with tissues, skin and lymph, pressure, character of the wound, etc. make the interpretation very difficult. In an exhaustive study of these points Solis-Cohen has analyzed all these points carefully. In spite of the unreliability of the method, it was decided in the present study to investigate the coagulation time. The methods of Bogg, Biffa, Lee and White and Howell were used. Those of Bogg and Biffa were first done on 115 normal individuals to get a standard. Up to 6 minutes was found normal with the Bogg's method (average range of 3 to 5 minutes) and up to 9 minutes for the Biffa method. In 60 cases of jaundice and in 25 miscellaneous pathological cases, the coagulation time was invariably found to be normal. Lee and White's method was done on 32 cases, and Howell's method on 30 cases. These were all normal.

In only 1 jaundice case was the Bogg's method above normal, 13 minutes. This patient

was operated upon and died, but of cholemia, not of hemorrhage. This would seem to indicate that the prolonged coagulation time in jaundice is not so much an index of bleeding tendency as of liver damage. Walters (35) agrees in this view.

Coagulation time, then, was also discarded along with calcium and other determinations as not being an accurate guide.

3 *Bleeding time* In bleeding conditions the simple fact is that the patient bleeds. The problem is how to demonstrate beforehand that he is going to bleed. Duke's bleeding time is used universally. To a large extent in jaundice it has been disappointing. Here it is of little more value than the coagulation time. True in severe anemia, febrile states, acute leucemias and in pronounced hemorrhagic diatheses in general it is prolonged, and is the single most reliable method of predicting a bleeding tendency. But a latent bleeding tendency, such as is found in many cases of jaundice, is not revealed by the ordinary puncture of the skin. Thus, it was felt that some way should be found to make a patient with a hypothetical latent bleeding tendency in jaundice bleed excessively from an ordinary skin puncture, and thus possibly make it manifest.

A factor which has received little attention in bleeding studies is the state of "tonicity" of the capillaries. In small vessels it is the retraction of their walls to a large extent which stops bleeding. No other factor can explain the fact that the normal bleeding time of 30 to 180 seconds (Duke) is much less than the normal coagulation time. Von Bermuth and Magnus have demonstrated this clearly, by actual observations of the capillaries with the capillary microscope. Magnus has shown that the normal capillary when cut, will contract force out its content of blood and then disappear completely from view because of its contraction. In a case of hemophilia, von Bermuth found that the capillaries did not contract after being cut but remained patent and continued to bleed. In a case of Werlhof's disease, however, the capillaries reacted in the normal manner. This field offers fascinating possibilities for study and should be investigated further.

It was felt that if the factor of capillary tonus could be eliminated and the capillaries kept wide open, the situation would be simplified and a latent bleeding tendency revealed if present. Such a situation is comparable clinically when ether, shock, operative trauma etc. results in capillary paresis and bleeding.

The skin of the forearm near the elbow over the pronator muscles was selected as being uniformly thin without the disturbing factor of differences in hornification present on the finger tips. Ordinary Duke's punctures (with mechanical stylet set a uniform depth of about 2.5 millimeters for all cases) gave the usual bleeding time as 30 seconds to 3 minutes. Heat was then applied and another puncture done. No constant change was noted. Cold was then used; no dependable difference could be noted. Histamine (which does not alter blood coagulability, Best and McHenry) was then injected intradermally to produce capillary paresis. No constant changes were found. Altogether 80 cases were studied in this manner.

One of us (A. C. I.) then suggested applying the cuff of a sphygmomanometer around the arm, with a pressure of about 40 millimeters of mercury enough to cut off effectively the venous return. By increasing the pressure in the capillaries and arterioles in this manner the factor of "capillary tonus" might be eliminated. This was done with most gratifying results.

It was found in a large number of normal individuals (115 cases) that very little difference existed between the Duke method and the modified method with venous pressure. In general, the latter gave somewhat longer readings and an increased volume of bleeding as demonstrated by the total area of the drops on the filter paper. After many trials the upper limit of normal for the venous pressure bleeding time was fixed at 240 seconds; it was rarely over 180 seconds. But, when the method was tried on a number of cases of jaundice it was found that often when the Duke's bleeding time was normal the venous pressure bleeding time was definitely prolonged. These cases with a prolonged venous pressure bleeding time were almost always found to be the cases that bled, either spontaneously or after

operation. In the following study of 810 pathological cases, this fact was demonstrated repeatedly. We are not prepared to say just what is the mechanism involved (blood chemical studies of diffusible calcium were made and will be reported separately) but we do feel convinced that the method is of distinct value in predicting a hemorrhagic diathesis in jaundice.

REFERENCES

1. BARCROFT F W KUGELMANN, I N and STANLEY BROWN, M. Evaluation of blood clotting factors in surgical diseases, etc. Ann Surg 1930, 90 161
2. BERGMUTH, F von Ueber das Verhalten von Kapillaren bei Blutergüssen, insbesondere bei der Hämorrhagie Arch f Kinderh 1925 76 54
3. BEST C H and MCLELLAN E. H. Coagulation in Physiol Rev 1931, 1 371
4. BLAND P B and J Obst & Gynec 937 23 815
5. BLAND P B and J Obst & Gynec 937 23 815
6. BLAND P B and J Obst & Gynec 937 23 815
7. BLAND P B and J Obst & Gynec 937 23 815
8. BLAND P B and J Obst & Gynec 937 23 815
9. BLAND P B and J Obst & Gynec 937 23 815
10. BLAND P B and J Obst & Gynec 937 23 815
11. BLAND P B and J Obst & Gynec 937 23 815
12. BLAND P B and J Obst & Gynec 937 23 815
13. BLAND P B and J Obst & Gynec 937 23 815
14. BLAND P B and J Obst & Gynec 937 23 815
15. BLAND P B and J Obst & Gynec 937 23 815
16. BLAND P B and J Obst & Gynec 937 23 815
17. BLAND P B and J Obst & Gynec 937 23 815
18. KUGELMANN, I N BARCROFT F W and STANLEY BROWN, M. Determination of coagulation time and regulation in childhood. Am J Dis Child 1930, 39 471
19. LEE, R. and VINCIGUERRA B. The relation of calcium to the delayed coagulation of the blood in obstructive jaundice Arch Int Med., 1915, 16, 59
20. LAWSON, R. Hematologic studies as basis for determining risk of post-operative hemorrhage in jaundiced patients. Ann Surg 1931 94 80
21. LAYTON, R. Sedimentation rate of blood as index of hemorrhagic tendency. Ann Surg 1930, 91 601
22. LAYTON, R. Relation of calcium to hemorrhagic diathesis in obstructive jaundice. Ann Surg 1931 93 707
23. LAYTON, R. Relation of blood fibrin to hemorrhagic diathesis in jaundice. Ann Surg 1932, 96 304
24. MAOYER, B. Experimentelle Untersuchungen über den segmentären Gefäßkrampf und des Blutungsstillstandes Arch f klin Chir., 1924, 130 237
25. MAYO, F C and BOWMAN, J L. Influence of complete removal of liver on blood coagulation. Proc Staff Meet. Mayo Clin. 1929, 4 325
26. MAYO-ROOSE, A W. The surgery of the gallbladder and bile ducts. Brit. M J 1894, 1 901
27. MCKINNEY, R. B. The management of common duct obstruction. Southern M J S 1932, 4 780
28. MILLER, C A. Relation of protein diet to thrombosis. Ann Surg., 1930, 91 459
29. MOSS, W. Experimental obstructive jaundice, effect on fibrinogen and coagulation. Proc. Soc. Exper Biol & Med 1931, 29 325
30. MURAKAMI, J and YAMAGUCHI, T. Fibrinogen and fibrin content of blood in internal disease. Ann. de med., 1922, 15 297
31. SEITZ, W E. The gallbladder J Okla. State M Ass 1932, 25 490
32. STUELL, A M and GRIFFIN, C H. Serum calcium in jaundice. Am J Physiol., 1930, 92 630
33. SOLER-CORREY, M. The coagulation time of the blood as affected by various conditions. Arch Int Med., 1911, 8 654, 850
34. WALTERS, W. Pre-operative preparation of patients with obstructive jaundice. Surg. Gynec. & Obst., 1921, 33 651
35. WALTERS, W. Obstructive jaundice from surgical standpoint. Minnesota Med 1932, 15 333
36. WALTERS, W. The hemorrhagic diathesis of obstructive jaundice and its treatment. Am. Surg 1925, 88 845
37. WEBB, C C. Pre-operative and post-operative treatment of surgical patients, without coagulopathy. J Florida Med Ass 1932, 10 241
38. WENTZ, A D. Surgery of the biliary tract. Surg Clin N America, 1931, 10 386
39. WRIGHT, V E and PARSONS, W E. On certain points in connection with the excretion and reduction of blood coagulability by therapeutic means. Lancet, 1906, 2 1906

THE EFFECT OF VIOSTEROL IN JAUNDICE¹

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THE bleeding tendency in jaundice is undoubtedly related to the degree of liver damage. The mechanism of this relation is obscure but the clinical facts are obvious. The venous pressure bleeding time, or "Ivy" bleeding time (as we have named it) is, therefore in a sense a measure of the degree of liver damage.² That this is true is also brought out by a study of other types of liver damage without jaundice. The Ivy bleeding time is prolonged in many cases of cirrhosis of the liver, in cases of chronic cholecystitis with associated liver damage etc. Cases with liver injury, then formed the bulk of those selected for study.

Dr. R. H. Jaffe suggested to us that a possible explanation for the bleeding tendency in cases of obstructive jaundice was that because of the deficiency of bile in the gastro-intestinal tract, there was a failure in absorption of fat soluble vitamins particularly vitamin D. As this work was being completed a publication appeared from the University of California which confirmed this suggestion. Greaves and Schmidt proved that in the absence of bile from the intestinal tract little or no vitamin D is absorbed. In non-obstructive jaundices or in any liver deficiency with a marked decrease in biliary intestinal content the vitamin D absorption is not completely inhibited but is definitely impaired. The exhibition of large doses of viosterol or the administration of bile salts with it, we thought might correct this deficiency.

The liver stores vitamin D and apparently utilizes it in its hemostatic functions (1, 4). Many reports have been recently published which demonstrate the profound effect of vitamins on the various blood coagulating factors (Kugelmass and Samuel 9, Woehliisch, Sherif and Baum, Lopez, Cramer and Drew and others). In particular the effect of vi-

tamin D in favorably altering these factors and in reducing the bleeding and coagulation time and bleeding tendency in various conditions, has been frequently reported (Phillips, Robertson, Corson and Irwin, 12, Selye, Sanford, Gasteyer and Wyat 15, Brougher, Richardson, Du Plessis, Kugelmass 8, Sincock, Shelling, Kaminsky and Davidson, Hess, Lewis and Rirkin 5, Jones, Rapaport and Hodes 6, Massengale and Nussmeier 11, Rohmer and Maryssael 14 and others). The effect of vitamin D in increasing the calcium content of the blood has received particular attention and the relationship between blood calcium and blood coagulation is widely accepted. Enteral exhibition of calcium however has only a slight effect on blood calcium and parenteral administration has only a transitory effect. Viosterol it was thought by its indirect action on calcium metabolism would have a more prolonged and decisive effect in favorably influencing the blood coagulation and bleeding time.

A review of the literature revealed, however that the evidence for the relationship between blood calcium and blood coagulation and for the relationship between vitamin D and blood calcium was in many cases indecisive and contrary. We decided therefore to study in our own cases the relationship between viosterol administration and blood calcium (this work will be reported in a separate paper) and in the meantime to determine clinically whether viosterol actually would decrease the bleeding tendency of cases of jaundice or hepatic insufficiency.

Eight hundred and ten unselected cases at the Cook County Hospital were studied in a period of 14 months. Almost all the jaundiced patients who entered the hospital during this period were studied namely those with common duct stone, cirrhosis of the liver with jaundice, toxic hepatitis, catarrhal jaundice, primary and metastatic carcinoma of the liver.

See Ivy, A. C., Shapiro, P. F. and Melnick, P. The bleeding tendency in jaundice. Surg. Gynec. & Obst. 1935 60 751-754.

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carcinoma of the extrahepatic bile ducts and of the head of the pancreas etc. Another large group included patients with liver damage but without jaundice such as cirrhosis of the liver without jaundice chronic cholecystitis, and cholelithiasis, etc. A miscellaneous group of jaundiced patients included pneumonia with jaundice cardiac decompensation with jaundice, etc. In addition various types of miscellaneous patients were studied mainly as controls such as various types of blood dyscrasias and anemias, purpura, tonsil cases with bleeding history etc.

The patients were grouped broadly into surgical and medical patients. In the surgical patients the practical aspect of postoperative bleeding was a measure of the effect of viosterol in addition to the lowered Ivy bleeding time. In the medical cases, the Ivy bleeding time was of chief value although cessation of spontaneous bleeding from the gastro-intestinal tract or other sources was also an indication of viosterol effect. In general the average dose of viosterol was 30 drops of 250d three times a day. In cases with acholic stools bile salts were also administered to insure the absorption of vitamin D. In addition calcium and glucose were sometimes administered orally or intravenously. Thus administration was irregular and was done in the control cases in about the same proportion as in the definitive group. For a time viosterol 10,000 was given to some patients but no difference could be noted in its action and it was discontinued. In general where the bleeding time was not prolonged no viosterol was given the course was usually uneventful. About one-third of the patients with a prolonged bleeding time, unselected, were used as controls and were not given viosterol.

SURGICAL CASES

SURGICAL CASES
1 Chronic cholecystitis and cholelithiasis
Among the surgical patients 254 were patients
with chronic cholecystitis and cholelithiasis
upon whom a cholecystectomy was performed.
In this group there were 219 (19 colored and

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200 white) who showed no bleeding tendency in any of the preliminary tests. They included 30 men and 189 women. No viosterol was given. In the whole group there were only 3 deaths, all from extrahepatic complications. One patient died of cardiac decompensation 2 weeks after operation, and 2 of bronchopneumonia 10 days after. One patient ran a stormy postoperative course. The rest, 215 patients, made an uneventful recovery. The Ivy bleeding time thus seems to have good prognostic value for when it is normal. Good results can be expected and viosterol is not indicated. Thirty five or 13.7 per cent of the patient (Table I) in this group (Table I) had a preliminary tendency to bleed.

g time thus seems to be normal. Good results are expected and viosterol is not indicated. Thirty five or 13.7 per cent of the patients (3 men and 32 women) in this group (Table I) showed a bleeding tendency on the preliminary tests. The Duke bleeding time averaged 120 seconds well within the normal range but the Ivy bleeding time averaged 320 seconds, quite above the normal upper limit of 240 seconds. Nineteen of the 35 patients gave a history of abnormal bleeding. The icteric index averaged 11. Of these 35 patients with a bleeding tendency 24 were given viosterol for from 4 days to 2 weeks before operation in doses of 30 to 60 drops three times a day. After this therapy the Duke bleeding time averaged 80 seconds, the Ivy bleeding time dropped to 130 seconds. Twenty two of these patients made uneventful postoperative recoveries and two ran stormy postoperative courses. There were no deaths.

As a control series, 11 of the patients were not given vosterol. Without vosterol preparation the Duke bleeding time before operation averaged 132 seconds, and the Ivy bleeding time averaged 346 seconds, still well above normal. In these cases there was no spontaneous bleeding, and 10 ran on a blood transfusion.

Thus, in these cases there was no spontaneous improvement in the bleeding time. One patient died in cholemia, and 10 ran stormy postoperative courses requiring blood transfusions and 4 to 6 weeks' stay in the hospital. There were no smooth recoveries. Here too the bleeding time was seen to have progressive improvement. When it is increased trouble can be expected unless it is first reduced by vascular therapy.

It is significant that at operation no unusual difficulty with haemostasis was noted even in the control cases. The patients went bad

TABLE L—SURGICAL GALL-BLADDER CASES WITH BLEEDING TENDENCY

Case number	Sex and color	Age	Icteric index	Bleeding tendency	Duke bleeding time	Ivy bleeding time	Viosterol	After viosterol					Results
								Mixing	Duke bleeding time	Ivy bleeding time	Operation	Postoperative bleeding	
153	♂	43	13	+	110	200	30 drops t i d 1 wk	0	60	150	+	0	Recovered
155	♀	48	8	0	140	310	30 drops t i d 1 wk	0	70	110	+	0	Recovered
156	♀	44	19	±	130	300	30 drops t i d 1 wk	0	50	90	+	0	Recovered
447	♀	43	8	±	130	360	30 drops t i d 1 wk	0	60	30	+	0	Recovered
445	♀	37		0	160	290	30 drops t i d 1 wk		60	108	+	0	Recovered
446	♀	40			140	290	30 drops t i d 1 wk	0	70	130	+		Recovered
61	♀	33	3	++	100	440	30 drops t i d 1 wk	0	40	150	+	0	Recovered
276	♀	37	18	+	160	300	30 drops t i d 1 wk	0	70	130	+		Stoimy convalescence recovery
227	♀	31	1	±	180	238	60 drops t i d 1 wk	0	40	100	+		Recovered
28	♀	43	4	0	100	280	30 drops t i d	0	70	118	+		Recovered
279	♀	46	5	±	190	330	30 drops t i d		70	120	+	0	Recovered
210	♀	43	20	0	80	450	60 drops t i d 1 wk 60 drops t i d 2 wks	0	50 100	400 140	+	0	Stoimy convalescence
23	♀	41	16	0	0	160	30 drops t i d		60	130	+	0	Recovery normal
310	♀	27		+	130	430	30 drops t i d	0	70	130	+		Recovery normal
311	♀	40		++	120	290	30 drops t i d	0	90	130	+	0	Recovery normal
512	♀	63	6	+	90	400	30 drops t i d	0	60	180	+	0	Recovery normal
513	♀	24		0	120	300	30 drops t i d	0	50	140	+		Recovery normal
523	♀	28			80	280	30 drops t i d	0	60	110	+	0	Recovery normal
524	♀	44	5	0	90	290	30 drops t i d	0	60	130	+	0	Recovery normal
525	♀	64	3	+	100	270	30 drops t i d	0	30	100	+		Recovery normal
526	♀	44		+	140	280	30 drops t i d		80	30	+	0	Recovery normal
527	♀	24	8	0	90	280	30 drops t i d	0	50	130	+		Recovery normal
73	♀	24		+	120	290	30 drops t i d	0	40	50	+	0	Recovery normal
528	♀	23		0	78	260	30 drops t i d	0	30	70	+	0	Recovery normal
161	♀	46	20	±	0	160	None	+	140	240	+	+	Stoimy P.O. course transfusion CCH 4 wks
633	♀	36		0	90	270	None	±	130	300	+	±	Stoimy P.O. course transfusion CCH 4 wks
634	♀	56			0	270	None	0	90	330	+	0	Stoimy P.O. course transfusion CCH 4 wks
635	♀	33	24	+	1	300	None	0	130	360	+	+	Stoimy P.O. course
636	♀	63	8	+	80	290	None		100	360	+	0	Stoimy P.O. course
637	♀	28		+	90	400	None	+	160	400	+	+	Stoimy P.O. course; transfusion
54	♀	30	15		60	290	None				+	+	Died in 3 days
430	♂	43		±	90	290	None 1 wk P.O. 3 wks P.O. 4 wks P.O.	± + 0 0	90 130 150 100	280 240 250 210	+	+	Stoimy P.O. course recovered after 4½ wks.
311	♀	44	20	±	90	298	None 1 wk P.O. 2 wks P.O. 3 wks P.O.	0 0 0 0	50 70 80 60	300 270 170 160	+	±	Collapse 3 hrs. P.O. blood transfusion 4 wks P.O. ad, recovery
33	♂	39	38	+	30	330	None 1 wk P.O. 2 wks P.O. 3 wks P.O.	± 0 0 0	90 50 50 60	210 150 100 110	+	±	Collapse P.O. transfusion 4 wks ad, recovery
733	♀	43		+	150	270	None	±	10	200	+	+	Stoimy convalescence course transfusion

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8 to 24 hours after operation. It occurred to us here that the reason for this is that jaundiced patients clot as quickly as normals, but that their clots are fragile, and the postoperative retching etc. breaks them loose. We have spent a great deal of time in studying the clots of these patients. The increased fragility of their clots in comparison with normal clots is obvious, but we have as yet been unable to devise an instrument to record this fragility accurately.

2 Common bile duct stone. Sixty-four patients with common bile duct stone were operated upon. Of these 27 men and 19 women showed no bleeding tendency. Their icteric index ranged from 16 to 150; their ages from 24 to 68. None of the 27 received viosterol except patient 26. All made uneventful postoperative recoveries except patients 26 and 24. Therefore in patients with normal liver and smooth spontaneous recovery bleeding time can usually be expected without viosterol. Patient 24 was a white woman 46 years old who had an icteric index of 35, no bleeding history and a bleeding time which was just within normal limits. She was in excellent general condition. She was not given viosterol but the night before operation was given 5 cubic centimeters of 10 per cent calcium chloride intravenously. She died suddenly 1 hour after the injection. He had an icteric index of 130. There was no bleeding history. He had a normal bleeding time, but was in poor general condition. For this reason he was given 30 drops of viosterol three times a day for 10 days. He died 4 days after operation in cholemia.

Thirty-seven or 57 per cent of the patients with common duct stone (11 men and 26 women) had an abnormally prolonged bleeding time. The Duke bleeding time averaged 125 seconds, but the Ivy bleeding time averaged 330 seconds. The icteric index averaged 58. Twenty-four of the 37 patients were given viosterol. The bleeding tendency stopped in all except patient 762. The Duke's bleeding time dropped in from 1 to 2 weeks to an average of 65 seconds, the Ivy bleeding time to 120. There was only 1 death patient 762 and only 1 stormy postoperative course.

As a control series, 13 of the 37 patients were not given viosterol. The bleeding tendency persisted in 11 of these 13 patients, the Duke's bleeding time rose to an average of 140 seconds, the Ivy bleeding time rose to an average of 385. There were 5 deaths, 8 stormy postoperative courses and no uneventful recoveries. This stands in striking contrast to the group with prolonged bleeding time who were given viosterol (Table II).

3. Surgical malignancies. Twenty-four surgical patients with carcinoma of the liver or of the extrahepatic bile ducts were studied. There were 16 men and 8 women (4 women) of these patients (10 men and 4 women) showed no bleeding tendency. Their ages varied from 40 to 72. No viosterol was given. Thirteen of the fourteen had exploratory laparotomies. One patient was in very poor condition when operated upon and died a few hours later. The rest made uneventful postoperative recoveries. One patient had a cholecystogastrostomy with an uneventful recovery.

Ten or 41 per cent of the patients (6 men and 4 women) showed a bleeding tendency (Table III). Six gave a history of bleeding and 4 gave a history of bleeding. The Duke bleeding time averaged 120 seconds, the Ivy bleeding time averaged 56. The Duke's bleeding time averaged 430 seconds. Eight of the 10 patients were given viosterol. The Duke's bleeding time within from 5 to 12 days dropped to an average of 75. The Ivy bleeding time to 190 seconds. Two patients on viosterol retained their bleeding tendency. One died in cholemia. The other ran a stormy postoperative course. A third patient was relieved of his bleeding tendency but died of cardiac decompensation 2½ weeks after operation. Five of the 6 whose bleeding tendencies were reduced made uneventful postoperative recoveries. As a control series, 3 patients remained un-

changed. The bleeding time remained uneventful. Both died in cholemia. In these patients, too, the same general relationship holds between the bleeding time and the prognosis. Also the effect of viosterol in keeping down the bleeding time and bleeding tendency for a time was noted. However where the liver is hopelessly damaged and risk-

TABLE II.—SURGICAL COMMON BILE DUCT CASES WITH BLEEDING TENDENCY

Case number	Sex and color	Age	Icteric index	Bleeding history	Duke bleeding time	Ivy bleeding time	Viosterol	After viosterol					Results
								Bleeding	Duke bleeding time	Ivy bleeding time	Operation	Postoperative bleeding	
834	Q	45	88	+	120	31	30 drops t i d 2 wks	0	50	80	+	0	Recovered
835	Q	38	58	+	150	190	30 drops t i d 1 wk	0	50	90	+	0	Recovered
836	Q	45	8	0	00	160	60 drops t i d 1 wk	0	70	120	+	0	Recovered
837	Q	45	65	0	30	250	30 drops t i d 1 wk	0	80	90	+	0	Recovered
838	Q	40	0	+	130	70	30 drops t i d 3 days	0	30	100	+	0	Recovered
839	Q	48	8	±	11	200	30 drops t i d 1 wk	0	50	80	+	0	Recovered
61	Q	61	36		70	190	30 drops t i d 1 wk	0	60	130	+	0	Stompy P O course
452	Q	38	44	0	40	300	30 drops t i d 1 wk		80	120	+	0	Recovered
453	Q	37	50	0	140	190	30 drops t i d 5 d	0	80	120	+	0	Recovered
454	Q	3	46	0	150	180	30 drops t i d 1 wk	0	80	120	+	0	Recovered
87	Q	21	36	+	30	40	60 drops t i d 1 wk		60	120	+	0	Recovered
88	Q	28	60	+	30	110	60 drops t i d 1 wk	0	30	120	+	0	Recovered
36	Q	48	100	+	80	160	30 drops t i d 1 d + bile salts 7 gr t i d	0	80	100	+	0	Recovered
10	Q	23	53	0	80	160	30 drops t i d 10 d		80	80	+	0	Recovered
695	Q	30	50	+	120	180	30 drops t i d 1 wk + bile salts 7 gr t i d	0	50	80	+	0	Recovered
696	Q	61	45	+	00	31	30 drops t i d 1 wk + bile salts 7 gr t i d	0	30	90	+	0	Recovered
814	Q	44	35		80	180	30 drops t i d 1 wk	0	60	120	+	0	Recovered
815	Q	60	4	+	110	300	30 drops t i d 1 wk	0	60	90	+	0	Recovered
816	Q	27	38	+	110	31	30 drops t i d 1 wk	0	00	130	+	0	Recovered
8	Q	27	28	++	160	180	60 drops t i d 1 wk	0	140	100	+	0	Recovered
8	Q	20	16	++	30	30	30 drops t i d 1 wk	0	30	50	+	0	Recovered
27	Q	47	34	+	120	300	30 drops t i d 1 wk	0	60	80	+	0	Recovered
761	Q	50	150	0	08	180	30 drops t i d 1 wk + bile salts 7 gr t i d	0	60	180	+	0	Recovered
762	Q	30	77	+	130	480	30 drops t i d 1 wk + bile salts 7 gr t i d	0	60	130	+	0	Died
162	Q	16	61	+	160	480	No viosterol	+	40	400	+	+	Died a few hrs P.O. of hemorrhage
218	Q	21	82	±	180	41	No viosterol	+	180	450	+	+	Died 1 hr P.O. of hemorrhage
697	Q	61	1	+	90	300	No viosterol	+	120	300	+	+	Died 1 day later
498	Q	30	65	+	70	450	No viosterol	+	160	350	+	+	Died 1 day later no autopsy
699	Q	30	16	0	100	150	No viosterol	0	80	120	+	0	Stompy P O course
700	Q	47	16	+	00	420	No viosterol	0	90	180	+	0	Stompy P O course
660	Q	43	28	+	80	270	No viosterol	+	90	300	+	+	Stompy P O course
384	Q	29	80	+	70	360	No viosterol 2 wks P O	0	120	460	+	0	Stompy P O course Still in C.C.H.
							No viosterol	+	120	300	+	+	P O collapse transfusion 5 wks recovery
37	Q	7	120	++	180	300	2 wks P O 5 wks P O	+	260	480	+	+	
758	Q	4	++	0	10	330	No viosterol				+	0	Stompy P O course
757	Q	55	++	+	60	420	No viosterol	+	90	490	+	0	Stompy P O course
759	Q	44	23	±	00	330	No viosterol	+	100	350	+	0	Stompy P O course
760	Q	51	14	+	70	310	No viosterol				+	+	Died

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TABLE III—SURGICAL MALIGNANCIES WITH BLEEDING TENDENCY AND VIOSTEROL

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TABLE III—SURGICAL MALIGNANCIES WITH BLEEDING TENDENCY AND
Explanatory Operation

Case number	Sex and color	Age	Diagnosis	Hemorrhage	Splenectomy	Duke	Ivy	Viosterol	After viosterol				Result	
									Bleeding	Operation	Duke	E.		
166	♀	31	Secondary carcinoma of liver	80		60	170	30 drops t. d. for 1 wk	+	+	30	300	Recovered	
47	♀	38	Secondary carcinoma of liver	3		300	260	30 drops t. d. for 1 wk	+	+	60	130	Recovered	
57	♀	39	Secondary carcinoma of liver	65	+	70	430	30 drops t. d. for 1 wk	+	+	60	50	Recovered	
518	♀	38	Secondary carcinoma of liver	7	+	30	970	30 drops t. d. for 1 wk	+	+	120	20	Recovered	
98	♀	6	Carcinoma of gall bladder	90	+	160	430	30 drops t. d. for 1 wk "calcium lactate, glucose, and transfusion after 1 wk	+	+	90	260	Died in 24 hrs. in cholelithiasis (Hagg's, 3 mos.)	
120	♂	34	Carcinoma of gall bladder	10		40	260	30 drops t. d. for 10 days	±	+	60	120	Stormy P.O. course	
3	♂	38	Carcinoma of gall bladder	54	+	70	140	30 drops t. d. wk + cal- cium gluconate	±	+	75	90	Recovered	
763	♀	49	Carcinoma papilla of Vater	35		60	170	30 drops t. d. wk + bile salts	+	+	30	230	Died day P.O.	
38	♂	30	Secondary carcinoma of liver	60	+	60	120	No viosterol		+	90	280	Died day P.O.	
35	♂	3	Secondary carcinoma of liver	70		60	80	No viosterol						

She was put on viosterol but transfusion was also given. Her bleeding time dropped to 15.0. The platelet count rose to 150,000. Splenectomy was unnecessary.

died by carcinoma nothing will help it. We were able to follow the gradually advancing destruction of the liver by the gradually increasing bleeding time and the failure of the patient to respond to viosterol.

4 Miscellaneous surgical cases. There were 2 patients with liver abscess. Neither showed a bleeding tendency. No viosterol was given. They were drained surgically and made uneventful recoveries. One patient with biliary cirrhosis, patient 393, was operated. She was 33 years old and had an icteric index of 150 and no bleeding tendency. She was not given viosterol. While in the hospital her Ivy bleeding time increased from 160 to 300. She was explored at that time. The postoperative bleed course was stormy and the prolonged bleeding time continued for 4 weeks when she began to recover slowly. One patient with a splenic anemia was operated upon. She was 55 years old and had a very high bleeding tendency (380 seconds Duke, 460 Ivy). No viosterol was given. Splenectomy was done. The patient died 1 week later with recurrent hemorrhages. One patient with a thrombocytopenic purpura, patient 764, had a Duke bleeding time of 510 seconds and an Ivy bleeding time of 670 and a platelet count of 70,000.

She was put on viosterol but transfusions were also given. Her bleeding time dropped to normal and the platelet count rose to 150,000. Recovery after splenectomy was uneventful. During the course of the year 29 tonsil patients were found (out of about 5,000 operations) who gave a bleeding history (15 males and 14 females). Their ages varied from 4 to 31 years. Only one of these, however, showed a slightly prolonged bleeding time (260 Ivy). No viosterol was given to any case. All even the latter made uneventful recoveries. There were no cases of serious bleeding other than a few cases on the basis of definite surgical injury to larger vessels. There were no deaths. Because of inadequate bleeding material nothing can be said regarding the use of viosterol before tonsillectomy.

MEDICAL CASES

1 Chronic cholecystitis and cholelithiasis. Eighty-two patients with chronic gall-bladder disease entered the hospital with symptoms of biliary colic, acute gastro-intestinal upsets, or chronic dyspepsia. There were 11 men and 71 women. Of these only 1 showed a bleeding tendency. No viosterol was given. All recovered promptly from their admission symp-

TABLE IV—MEDICAL COMMON BILE DUCT CASES

Case number	Sex and color	Age	Icteric index	Bleeding	Duke	Ivy	Viosterol	After viosterol			Result
								Bleeding	Duke	Ivy	
534	♀	26	59		90	470	30 drops t i d 2 wk + bile salts wk.	0	90	150	Improved, refused operation
703	♀	30	19		90	41	30 drops t i d 2 wk + bile salts 2 wk	0	70	190	Improved, refused operation
704	♀	30	62	+	70	450	30 drops t i d 10 days + bile salts 10 days		50	140	Improved, refused operation
676	♂	43	32	0	30	240	Calcium only		60	90	Slow improvement, refused operation
705	♀	23		++	160	440	No viosterol	++	200	430	Died 2 days
783	♀	45	38	0	30	300	30 drops t i d 2 wk + bile salts	0	80	200	Refused operation
781		48	++	0	30	80	No viosterol	±		170	Refused operation

toms. Operation was not advised for the time being in many of the cases, in the remainder, the patients refused operation and left the hospital. One patient, 355, a man 47 years old entered the hospital with an acute cholecystitis. He had a bleeding history and a prolonged bleeding time (Duke 230 seconds, Ivy 550). He was not given viosterol. Operation was advised but he refused and left the hospital.

2 Common duct stone. Fourteen patients with common bile duct stone were studied who did not come to operation. There were 8 men and 6 women. Seven patients showed no bleeding tendency. They had an icteric index of 27 to 70. No viosterol was given. All made a spontaneous temporary recovery from their jaundice and gastro-intestinal symptoms.

Seven patients manifested a bleeding tendency (Table IV). Two gave a history of bleeding, Duke's bleeding time averaged 90 seconds, Ivy bleeding time 400 seconds. The icteric index averaged 38. Four of these were given viosterol and bile salts. The Duke bleeding time within 1 to 2 weeks averaged 70, the Ivy bleeding time dropped to 140 seconds. All 4 recovered. One patient received calcium only. She improved slowly. Two patients received no medication. The bleeding time remained unchanged in 1 and the patient died. In the other it grew steadily longer and the patient steadily worse. The prognostic value of the Ivy bleeding time and efficacy of viosterol in improving prognosis is shown in these as in the surgical patients.

3 Empyema of gall bladder. One patient with empyema of the gall bladder, patient 356,

a man 44 years old was admitted in poor condition. Viosterol was not tried. He died in 2 days. Another similar patient, 601, was prepared with viosterol. She began to recover spontaneously and refused operation. The correct diagnosis in this case is in question.

4 Catarrhal jaundice. Fifty-one patients with catarrhal jaundice were studied. 36 men and 15 women. Thirty-six patients showed no bleeding tendency. They had an icteric index of from 18 to 100. Their ages varied from 15 to 55. No viosterol was given. All recovered promptly within 2 weeks.

Fifteen patients, or 29 per cent, had a prolonged bleeding time, the Duke bleeding time averaged 115 seconds, the Ivy 330 seconds (Table V). Twelve gave a history of abnormal bleeding. The icteric index averaged 58. Twelve of the 15 were given viosterol. The bleeding tendency stopped in all within 1 to 3 days. The Duke bleeding time dropped within 3 to 6 days to an average of 70 seconds, the Ivy to 100 seconds. All 12 recovered promptly within from 5 days to 2 weeks. Three of the 15 were not given viosterol. One was ill for 7 weeks, 1 for 6 weeks, and only 1 recovered with usual promptness. Although catarrhal jaundice is a self-limited disease, it seems that when a prolonged Ivy bleeding time clouds the prognosis, viosterol is of value.

5 Cirrhosis of the liver. There were 104 patients with cirrhosis, 56 men and 48 women. Most of these were periportal cirrhosis, a few were biliary. Only 4 of the patients were colored.

Forty-seven patients showed no bleeding tendency. No viosterol was given, but the

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TABLE V—CATARRHIAL JAUNDICE

Case number	Sex and color	Age	Icteric index	Bleeding tendency	Duke's bleeding time	Ivy bleeding time	Vioosterol	After viosterol			Result
								Blackened	Blackened	Blackened	
94	♀	32	46	+	70	300	30 drops i. d. wk		60	120	Recovery wk
95	♂	3	78	++	70	300	30 drops i. d. 30 days		60	70	Recovery 30 days
96	♀	28	30	++	70	330	30 drops i. d. wk		60	70	Recovery wk
97	♀	43	66	+	90	370	30 drops i. d. wk		60	90	Recovery 3 wks
98	♀	5	82	+++	70	300	30 drops i. d. 20 days		60	130	Recovery 10 days
99	♂	30	30	+	70	300	30 drops i. d. wk		60	70	Recovery wk
100	♂	3	83	+++	70	300	30 drops i. d. wk		60	90	Recovery wk
101	♂	3	83	+++	70	300	30 drops i. d. wk		60	100	Recovery 3 days
102	♀	24	78	+++	70	300	30 drops i. d. 3 days		60	70	Recovery wk
103	♀	3	86		30	300	30 drops i. d. wk		60	90	Recovery wk
104	♂	43		++	70	300	30 drops i. d. wk		60	90	Recovery wk
105	♀	53		+	90	300	30 drops i. d. 3		60	100	Finally recovered after 7 wks
106	♀	33			90	300	No viosterol—7 wks		60	100	Left hospital after 6 wks condition only fair
107	♀	20			90	300	No viosterol—6 wks		60	90	Recovery 30 days
108	♀						No viosterol—10 days				
109	♀	30	84								

patients were under observation in the hospital for from 3 to 6 weeks. Their icteric index ranged from 7 to 94 their ages from 36 to 62. Forty two of these patients were stationary while under observations or improved slightly. One patient, 468, a man 38 years old had a low bleeding time but was nevertheless moribund on admission. He died the next day.

Fifty seven patients, or 54 per cent with cirrhosis had a prolonged bleeding time. The Duke bleeding time averaged 128 seconds, the Ivy 350 seconds. Thirty-eight of the 57 cases gave a history of abnormal bleeding. The icteric index averaged 44.

Thirty of the 57 patients were given viosterol (Table VI). Six of them died in the course of 3 to 6 weeks although none was moribund on admission. The bleeding tendency of these 6 did not abate on the administration of viosterol. The Duke bleeding time rose to 190 the Ivy to 460. Two patients were stationary, one made slight improvement. Four patients improved moderately and 17 patients improved markedly while under viosterol treatment. In the 24 patients in this group on viosterol who survived the bleeding tendency subsided in from 1 to 4 weeks. The Duke time fell in from 1 to 4 weeks to an average of 75 seconds, the Ivy to 150 seconds. In 2 of the patients who were improving the viosterol was stopped. One of them became rapidly worse but is still alive the other died.

Twenty-seven of the 57 patients with bleeding tendency were not given viosterol despite their prolonged bleeding time (Table VII). There were 14 deaths, but 9 patients were moribund on admission therefore only 5 cases can be counted to compare with the cases receiving viosterol. The striking contrast was that 9 of the control patients ran a progressive downhill course. 1 was stationary, 1 showed a slight improvement, and only 1 showed a marked improvement when viosterol was withheld. In these last 13 patients who are still living the Duke bleeding time averaged 90 seconds, the Ivy time remained at 310.

It seems that in cirrhosis of the liver with a prolonged bleeding time, if the process is early or slow in its progress, viosterol has some

TABLE VI.—CIRRHOSIS CASES WITH BLEEDING TENDENCY AND VIOSTEROL

Case number	Sex and color	Age	Serum index	Bleeding history	Date bleeding time	Ivy bleeding time	Viosterol	After viosterol			Results
								Bleeding	Date bleeding time	Ivy bleeding time	
247	M	51	24	0	60	300	30 drops t i d 3 wks	0	80 60	170 110	Marked improvement
607	F	43	24	+	120	360	30 drops t i d 3 wks	0	70	170	Marked improvement
75	F	40	5	0	90	30	30 drops t i d 3 wks	0	60	100	Marked improvement
77	F	24	23	+	30	610	30 drops t d 4 wks	0	50	110	Marked improvement
718	F	47		+	50	30	30 drops t d 3 wks	0	60	100	Marked improvement
849	F	24	24	++	120	610	30 drops t i d 4 wks	0	50	110	Marked improvement
716	F	48	44	+++	50	350	30 drops t d 3 wks	0	70	90	Remarkable recovery Viosterol stopped as 4 wks began to go bad, 5 wks later bleeding began again. Dose 150 Ivy 430
248	F	38		0	60	100	30 drops t d 3 wks	0	60	90	Moderate improvement
100	F	30	9	+	30	250	60 drops t i d 3 wks		100	60	Moderate improvement
101	F	20	14	+	90	350	60 drops t d 3 wks		90	180	Moderate improvement
249	F	56	24	0	11	260	60 drops t i d 3 wks	0	80	160	Moderate improvement
51	F	60	20		110	260	30 drops t i d 3 wks		70	130	Moderate improvement
177	F	36	25	+	180	300	30 drops t i d 3 wks		60	100	Moderate improvement
78	F	27	20	0	130	170	30 drops t d 3 wks	0	70	90	Moderate improvement
6	F	4	25	+	300	270	30 drops t d 3 wks	0	100	130	Moderate improvement
73	F	4	4	+++	10	430	30 drops t d 4 wks	0	70	150	Moderate improvement
714	F	43		+	180	300	30 drops t i d 3 wks	0	60	150	Moderate improvement
465	F	64		0	180	900	30 drops t i d 4 wks	0	180	150	Moderate improvement
466	F	33	30	++	30	460	30 drops t i d 6 wks	0	160	140	Moderate improvement
79	F	26	16	+	160	250	30 drops t i d 3 wks	0	80	160	Slight improvement
90	F	56	18	±	140	30	60 drops t i d 4 wks	0	90	90	Slight improvement
13	F	35	25	+++	130	360	30 drops t i d 1 wk 60 drops t i d 2 wks 90 drops t i d 3 wks	+++ +++ +++	30 250 330	130 460 300	No improvement No improvement No improvement
23	F	40	37	+++	140	400	60 drops t i d 3 wks	++	130	400	Steadily worse, died
23	F	33	76	+	90	300	60 drops t i d 10 days	+	90	180	Steadily worse, died
27	F	41	6	+	80	260	30 drops t i d 3 wks	++	300	610	Steadily worse, died
719	F	51	25	++	300	330	60 drops t d 4 wks 3 drops t i d (10,000X) 4 wks	+++ +++	230 300	460 500+	Steadily worse, died Steadily worse, died
76	F	47	73	++	14	450	30 drops t i d 1 wk 30 drops t d 1 wk Viosterol 1 wk No viosterol 1 day more	+ + +	120 80 100	270 70 290	Died of massive hematoma
246	F	21		++	300	230	30 drops t i d 1 wk 60 drops t d 1 wk 10,000X—30 drops t i d 1 wk	++ +++ +++	230 270 300	430 460 500+	Died
805	F	45	147		300+		30 drops t i d 1 wk		30	460	No change
806	F	43	16	0	130	430	30 drops t i d 1 wk		110	300	Slight improvement

value, while if it is advanced or rapid in its progress viosterol has no demonstrable value

6 Malignancy There were 68 patients with malignancy in and about the liver who did not come to operation. They included 41 men and

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TABLE VII—CIRRHOSIS CASES WITH BLEEDING TENDENCY WITHOUT VIOSTEROL									
No.	Age	Sex	Occupation	Duration of illness	Site of bleeding	Amount of bleeding	Time of bleeding	Time of onset	Result
1	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
2	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
3	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
4	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
5	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
6	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
7	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
8	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
9	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
10	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
11	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
12	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
13	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
14	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
15	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
16	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
17	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
18	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
19	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
20	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
21	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
22	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
23	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
24	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
25	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
26	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
27	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
28	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
29	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
30	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
31	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
32	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
33	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
34	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
35	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
36	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
37	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
38	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
39	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
40	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
41	45	F	Housewife	10 years	Stomach	100 cc.	10 days	10 days	Death
42	55	M	Farmer	5 years	Stomach	50 cc.	5 days	5 days	Death
43	60	F	Housewife	15 years	Stomach	100 cc.	10 days	10 days	Death
44	50	M	Farmer	10 years	Stomach	100 cc.	10 days	10 days	Death
45	45								

Case number	Sex and color	Age	Letter number	Blindness history	Double bleeding time	Try bleeding time	Visual level	Double bleeding time	Try bleeding time	Remarks
405	♂	64		+		1	No visual to days			Marked improvement
7	♂	45			30	130	No visual to days		70	20
130	♀	43			300	350	No visual to days		20	30
406	♀	66			10	260	No visual to days		130	300
407	♀	38			80	70	No visual to days		30	300
408	♀	38			80	300	No visual to days		30	300
409	♀	38			80	300	No visual to days		30	300
410	♀	38			80	300	No visual to days		30	300
411	♀	38			80	300	No visual to days		30	300
412	♀	38			80	300	No visual to days		30	300
413	♀	38			80	300	No visual to days		30	300
414	♀	38			80	300	No visual to days		30	300
415	♀	38			80	300	No visual to days		30	300
416	♀	38			80	300	No visual to days		30	300
417	♀	38			80	300	No visual to days		30	300
418	♀	38			80	300	No visual to days		30	300
419	♀	38			80	300	No visual to days		30	300
420	♀	38			80	300	No visual to days		30	300
421	♀	38			80	300	No visual to days		30	300
422	♀	38			80	300	No visual to days		30	300
423	♀	38			80	300	No visual to days		30	300
424	♀	38			80	300	No visual to days		30	300
425	♀	38			80	300	No visual to days		30	300
426	♀	38			80	300	No visual to days		30	300
427	♀	38			80	300	No visual to days		30	300
428	♀	38			80	300	No visual to days		30	300
429	♀	38			80	300	No visual to days		30	300
430	♀	38			80	300	No visual to days		30	300
431	♀	38			80	300	No visual to days		30	300
432	♀	38			80	300	No visual to days		30	300
433	♀	38			80	300	No visual to days		30	300
434	♀	38			80	300	No visual to days		30	300
435	♀	38			80	300	No visual to days		30	300
436	♀	38			80	300	No visual to days		30	300
437	♀	38			80	300	No visual to days		30	300
438	♀	38			80	300	No visual to days		30	300
439	♀	38			80	300	No visual to days		30	300
440	♀	38			80	300	No visual to days		30	300
441	♀	38			80	300	No visual to days		30	300
442	♀	38			80	300	No visual to days		30	300
443	♀	38			80	300	No visual to days		30	300
444	♀	38			80	300	No visual to days		30	300
445	♀	38			80	300	No visual to days		30	300
446	♀	38			80	300	No visual to days		30	300
447	♀	38			80	300	No visual to days		30	

27 women Forty five of these patients showed no bleeding tendency Thirty-eight of them were secondary carcinomata of the liver 1 was a carcinoma of the gall bladder 3 were carcinoma of the head of the pancreas, and 3 were carcinomata of the common bile duct No viosterol was given All were under observation for 2 to 7 weeks All were either stationary or showed only a slow decline except 2 patients, 404 and 794. Patient 404 was a man 60 years old with an icteric index of 145 He had a low bleeding time but died apparently of cardiac decompensation Patient 794

died although the bleeding time was normal. Twenty three of the 68 patients showed a bleeding tendency (Table VIII). There were 15 secondary carcinomata of the liver, 4 of the common bile duct, 3 of the pancreas, and 1 of the gall bladder. The Duke bleeding time averaged 150 seconds the Ivy 355. Eight of these were given viosterol. Three died but was moribund when treatment was started. Two became steadily worse, 2 remained unchanged and 1 improved slightly. In the group the Duke bleeding time remained at 120, the Ivy at 330.

TABLE VIII.—MEDICAL MALIGNANCIES WITH BLEEDING TENDENCY

Case number	Sex and color	Age	Diagnosis	Icteric index	Bleeding	Duke	Ivy	Viosterol	After viosterol			Result
									Bleeding	Duke	Ivy	
261	F	54	Carcinoma of stomach	32	+	110	280	30 drops t.i.d. 2 wks	0	80	150	Slightly improved refused operation
221	F	54	Secondary carcinoma of liver	36	0	30	150	30 drops t.i.d. 2 wks	+		300	Steadily worse
248	F	70	Secondary carcinoma of liver	130	+	130	390	60 drops t.i.d. 1 wk.	+	170	250	
								60 drops t.i.d. 1 wk	+	300	470	
								5 drops 10,000X t.i.d. 2 wks	±	300	300	
								5 drops 10,000X t.i.d. 2 wks	0	80	280	Steadily worse
106	F	80	Secondary carcinoma of liver	30	+	150	270	60 drops t.i.d. 1 wk. + calcium lactate	+	130	300	Died
105	F	76	Secondary carcinoma of liver	0	0	100	280	60 drops t.i.d. 1 wk.	+	300	420	Died
476	F	76	Secondary carcinoma of liver		3+	970		10 drops 10,000X t.i.d.				Moribund, died
700	F	81	Carcinoma extra-hepatic bile ducts	4+	+	70	750+	30 drops t.i.d. + bile salts				Died
795	F	81	Carcinoma extra-hepatic bile ducts	100	0	70	410	30 drops t.i.d. + bile salts 1 wk		60	300	No change
721	F	83	Carcinoma of gall bladder	00	4+	80	430	No viosterol	+	300	410	Worse
410	F	44	Secondary carcinoma of liver	11	0	30	140	No viosterol 1 wk. No viosterol 2 wks	0	170	240	Died
									+	150	230	
419	F	53	Secondary carcinoma of liver		0	110	280	No viosterol 1 wk. No viosterol 2 wks	0	130	230	Died
									+	100	230	
413	F	38	Secondary carcinoma of liver	86	0	90	260	No viosterol 1 wk. No viosterol 2 wks	0	200	240	Died
									+	100	240	
411	F	65	Secondary carcinoma of liver		0	30	80	No viosterol	+		420	Died
403	F	44	Carcinoma of gall bladder	37	0	70	300	No viosterol	0	100	260	Died
347	F	28	Carcinoma head of pancreas	73	+	100	260	No viosterol	0	130	290	Died
730	F	25	Secondary carcinoma of liver	30	4+	130		No viosterol				Died
473	F	73	Secondary carcinoma of liver		0	180	600	No viosterol				Died
580	F	30	Secondary carcinoma of liver	28	4+	90	200	No viosterol				Died
690	F	53	Secondary carcinoma of liver	16	3+	210	430	No viosterol				Died
261	F	80	Carcinoma of gall bladder	145	+	150	280	No viosterol				Died
797	F	50	Carcinoma head of pancreas	71	0	190	310	No viosterol			740+	Died
106	F	47	Carcinoma of common duct	4+	+	190	430	No viosterol		280	540	Died
708	F	65	Secondary carcinoma of liver	+	+	80	250	No viosterol				Died
704	F	70	Carcinoma of common duct	4+	+	30	30	No viosterol				Died

Fifteen patients were not given viosterol. Twelve died, but 5 were moribund on admission leaving 6 deaths to compare with 2 of the other series. One patient became slightly worse, none showed even slight improvement. The Duke bleeding time remained at 130, the Ivy at 350. Viosterol was of no demonstrable value in these cases.

7 Cardiac decompensation with jaundice. There were 9 patients, 5 men and 4 women. Seven of them showed no bleeding

tendency. All gradually improved under the usual cardiac therapy. One case was given viosterol but made no better improvement than the others. Two patients had prolonged bleeding time. One patient, 266, a man 41 years old, had an icteric index of 46, a Duke bleeding time of 150 and an Ivy bleeding time of over 600 seconds. He was moribund on admission. Viosterol was not given. He died the next day. One patient, 414, a man 57 years old, with an icteric index of 36 and an Ivy

TABLE IX.—TOXIC HEPATITIS WITH BLEEDING TENDENCY

Case number	Sex and color	Age	Diagnosis	Bleeding time	Ivy bleeding time	Duke	Ivy	Viosterol	After viosterol			Result
									Bleeding	Duke	Ivy	
107	F	58	Toxic hepatitis	65	+	30	130	No viosterol + wk.		70	280	Dying worse
								No viosterol wk.	±	100	340	Getting worse
								30 drops t. i. d. wk.		70	270	Improving
								60 drops t. i. d. wk.		70	70	Recovered
78	F	33	Toxic hepatitis	58	+	100	130	60 drops t. i. d. wk.		80	70	Recovered
603	F	18	Toxic hepatitis	100		60	150	30 drops t. i. d. 10 days			70	Recovered
746	F	27	Toxic hepatitis	60	+	30	260	3 drops 10, 20, 30 t. i. d. wk.			60	Recovered
120	F	34	Toxic hepatitis		+	100	300	No viosterol		70	70	Recovered
57	F	24	Toxic hepatitis	35		120	260	No viosterol		70	180	Recovered
766	F	20	Toxic hepatitis	++	+	100	600	No viosterol	+		300-1	Worse
3	F	47	Toxic hepatitis	80		30	300	3 drops 10, 20, 30 t. i. d. wk.			60	Improved, recovered
			(Second admission)	58	++	110	410	30 drops t. i. d. wk.	0		120	Recovery

bleeding time of over 600 was given large doses of viosterol (60 drops three times a day). He died in 3 days. Viosterol was of no value in these cases.

8 Toxic hepatitis. Fourteen patients with toxic hepatitis were studied, 4 women and 10 men. Six showed no bleeding tendency and recovered promptly. Eight had prolonged bleeding times (Table IX). The Duke bleeding time averaged only 88 seconds, but the Ivy averaged 310. Five were given viosterol. Three were not. All recovered promptly. The Duke bleeding time decreased to 65 seconds, the Ivy dropped to 110. Of course, no effect from viosterol was demonstrated. However, 1 patient, 107, a colored woman 58 years old had a low bleeding time on admission. Viosterol was not given. She began to grow worse. Viosterol was then given, she improved rapidly. Patient 787 had a prolonged bleeding time which dropped to normal under viosterol therapy. Treatment was stopped and he left the hospital. He returned 1 month later with recurrent hemorrhages and prolonged bleeding time. Viosterol again brought his bleeding time down to normal and stopped his bleeding.

9 Miscellaneous. There were 15 patients with jaundice with miscellaneous conditions such as pneumonia, portal thrombophlebitis, ascending cholangitis, pyelonephritis, miliary

tuberculosis and Bant's disease (Table V). Viosterol was given in most of the cases in which the Ivy bleeding time was prolonged. The results seemed to depend largely on the basic condition rather than on the jaundice. At any rate, there were too few similar cases in this series to warrant conclusions.

10 Pernicious anemia. Seventeen patients with pernicious anemia were studied, 7 women and 10 men. Eleven had no bleeding tendency and showed a prompt remission under liver therapy. Six patients showed a bleeding tendency (Table VI). The Duke bleeding time averaged 150 seconds, the Ivy 340. Four were given viosterol and 2 were not. All however showed a prompt remission. The Duke bleeding time fell to 60 seconds, the Ivy to 115.

11 Leucemia. There were 11 patients with leucemia. Three of these chronic myeloses had no bleeding tendency. Viosterol was not given. They improved slightly while under observation and left the hospital. Eight of the leucemias showed a marked bleeding tendency (Table VII). The Duke bleeding time averaged 380 seconds, the Ivy 500 seconds. Six of the patients were given viosterol, 2 were not. The bleeding time went even higher in all and all patients died. Viosterol was of no value in these cases.

TABLE X.—MISCELLANEOUS MEDICAL JAUNDICED CASES WITH BLEEDING TENDENCY

Case number	Sex and color	Age	Diagnosis	Icteric index	Bleeding	Date	Ivy	Viosterol	After viosterol			Result
									Bleeding	Date	Ivy	
55	♀	40	Portal thrombophlebitis	18	++	70	330	30 drops t.i.d. 10 days	0	60	80	Recovery
60	♂	33	Ascending pyelonephritis	+	+	70	260	30 drops t.i.d. 1 wk	0	70	60	Recovery
479	♀	38	Banti's disease	93	+	270	390	No viosterol	+			Died
780	♀	40	Ascending cholangitis	33	0	140	330	No viosterol	+	180	340	Died
807	♀	30	Purpura	37	0	160	240	30 drops t.i.d. 9 days	0	30	90	Recovery
808	♀	33	Purpura	33	0	130	34	No viosterol	+	130	340	Died
60	♀	35	Empyema of gall bladder	+	+	140	380	30 drops t.i.d. 10 days + bile salts	0	70	160	Recovery
156	♂	44	Empyema of gall bladder	33	0	80	370	No viosterol				Dead

TABLE XI.—PERNICIOUS ANÆMIA

Case number	Sex and color	Age	Bleeding	Date	Ivy	Viosterol	After viosterol			Result
							Bleeding	Date	Ivy	
278	♀	36	+	280	300+	60 drops t.i.d. 1 wk. 60 drops t.i.d. 1 wk. 60 drops t.i.d. 1 wk. + liver	0 0 0	260 120 90	430 230 130	Remission Roggs's, 5 mm. Howell, 12 mm. Platelets 130,000
277	♂	33	+++		290	40 drops t.i.d. 1 wk. 40 drops t.i.d. 1 wk. + liver	0 0		160 140	Remission Howell, 9 mm. Platelets 210,000
480	♀	46	+	240	250	30 drops t. d. 1 wk. + liver	0	60	90	Remission Roggs's, 4 mm.
299	♂	37	0	200	280	1 drop 10,000X t.i.d. 3 days + liver	0	60	130	Remission Roggs's, 4½ mm. Platelets 160,000
717	♂	58	0	30	260	No viosterol, liver only	0	30	100	Remission
728	♀	54	0	160	270	No viosterol, liver only	0	40	100	Remission

12 *Secondary anemia* Fourteen patients with secondary anemia were studied. Six of them showed a prolonged bleeding time (Table XIII). The results of viosterol therapy, however were inconclusive.

13 *Purpura* There were 13 patients with purpura, 3 patients with toxic purpura, and 1 of septic purpura showed normal bleeding time. Viosterol was not given, all recovered promptly. Nine patients had prolonged bleeding times (Table XIV). Of these 1 case of septic purpura improved, while another similar case did not improve under viosterol therapy. Two patients with toxic purpura were given viosterol and recovered. Of the 6 patients with thrombocytopenic purpura, 2 were not given viosterol. They grew slowly worse. Two were given viosterol, 1 gradually

improved, the other died. The fifth case 119, came in bleeding very copiously. Whole blood injections controlled the hemorrhages, and the patient slowly recovered after a 4 weeks' illness. Then he had a recurrence. This time viosterol was given without blood injections, he stopped bleeding in 3 days and remained well while under observations for over a month. The value of viosterol was not demonstrated in these cases. The one prompt remission was gratifying but lack of duplication in other cases renders conclusions unjustifiable.

14 *Endocarditis* Four patients with endocarditis were studied. One case of rheumatic endocarditis with no bleeding tendency improved spontaneously. The three patients with malignant endocarditis showed a marked

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TABLE XII.—LEUCÆMIAS

Case	Sex	Age	Diagnosis	Hb	Dk	T	Viosterol	After viosterol			Result
								Hb	Dk	T	
7	♂	24	Monocytic leucæmia	3+	450+	400	30 drops t i d wks	4+	500+	400	Died, platelets 1,000,000
82	♀	45	Lymphatic leucæmia	+	300+	400	30 drops t i d wks + X-ray therapy	4+	500	400	Died, Howell, 7 mm
259	♂	8	Acute leucæmia	4+	500+	400	5 drops 30,000X t i d wks	4+	500+	400	Died
360	♀	16	Acute leucæmia	4+	500+	400	60 drops t d 3 wks 5 drops 30,000X t i d wks 5 drops 30,000X t i d wks	4+	500	400+	Died
177	♂	4	Acute leucæmia	4+	500+	400	30 drops t i d wks	4+	500+	400	Died, platelets 400,000
8	♀	46	Myeloid leucæmia	3+	450	400	30 drops t d 5 days	4+	500+	400	Died, platelets 300,000
283	♀	2	Myeloid leucæmia	3+	450	400	No viosterol				
426	♀	46	Lymphatic leucæmia	+	300	400	No viosterol				

TABLE XIII.—SECONDARY ANÆMIAS

Case	Sex	Age	Diagnosis	Hb	Dk	T	Viosterol	After viosterol			Result
								Hb	Dk	T	
1	♂	30	Secondary anæmia	3+	450	350	30 drops t d 4 days	+	60	150	Improved
118	♂	33	Secondary anæmia	+	300	350	30 drops t i d 3 days	+	70	150	Improved
6	♂	7	Er, thrombocytic anæmia	3+	60	350	30 drops t i d wks 30 drops t d 3 wks 30 drops t d 3 wks	+	70	150	Platelets 60,000 R.B.C. 1,500,000, W.B.C. 15,000
63	♂	2	von Jaksch's anæmia	+	450+	400	15 drops t d wks	+	500+	400	Reduced liver therapy R.B.C. 1,500,000 W.B.C. 15,000, died
49	♂	61	Aplastic anæmia	3+	500+	400	60 drops t i d 3 days	+	+	+	Died
52	♂	64	Secondary anæmia, bleeding gastro-intestinal carcinoma	3+	50	400	30 drops t i d wks	+	+	+	Gastro section, died in shock

bleeding tendency. Two were given viosterol one was not all died.

15 Other miscellaneous patients. There were 11 miscellaneous patients with hæmophilia, Bantus disease, scurvy, pellagra, tularæmia, ascites etc (Table XV). Viosterol was given to all patients with a bleeding tendency but there were too few similar cases to warrant conclusions. One patient with dermatographism had no bleeding tendency but was given viosterol to observe its effect. There apparently was no effect. The patient had a severe attack of hives while under treatment.

It is interesting to note that in 5 apparently normal individuals who were found to have a prolonged bleeding time (Table XV) the

bleeding time returned to normal after from 2 to 5 days of viosterol administration.

SUMMARY AND CONCLUSIONS

There is no single method of predicting a bleeding tendency which is applicable to all types of hæmorrhagic diatheses. In the various types of bleeding dyscrasias, it is probable that various factors are responsible and that different tests are required to demonstrate the bleeding tendency in each. Thus, in purpura the platelet count in hæmophilia the Howell method of coagulation time determination are the most reliable methods of predicting a bleeding tendency. In jaundice or in any liver deficiency neither of these methods nor the Biffi nor Bogg, nor Lee and White method of

TABLE XIV—PURPURAS

Case number	Sex and color	Age	Diagnosis	Bleeding	Duke	Ivy	Viosterol	After viosterol			Result
								Bleeding	Duke	Ivy	
122	♀	17	Septic purpura	+	180	300	30 drops t.i.d. 2 wks	0	20	170	Recovered
123	♂	14	Septic purpura	+	120	120	30 drops t.i.d. 2 wks	+	170	350	No improvement
170	♂	40	Toxic purpura	+	200	250	30 drops t.i.d. 1 wk	±	60	110	Recovered
1	♀	65	Toxic purpura	+	70	250	30 drops t.i.d. 1 wk	0	40	70	Recovered
416	♀	24	Thrombocytopenic purpura	+++	80	300	No viosterol 1 wk. No viosterol 2 wks	+++ 4+	90 140	250 200	Steadily worse platelets 50,000
485	♂	36	Thrombocytopenic purpura	++	260	300	No viosterol 1 wk. No viosterol 2 wks	++ 3+	150 250	170 150	Steadily worse platelets 50,000
50	♂	24	Thrombocytopenic purpura	++	80	300	30 drops t.i.d. 2 wks	0	80	180	Improved platelets 150,000
110	♀	4	Thrombocytopenic purpura Bleeding returned platelets 50,000 No further bleeding for a month of observation	4+	600+	1000+	No viosterol, blood injections No viosterol, blood injections 1 wk 30 drops t.i.d. 3 days	2+ 0	170 80	250 120	Boggs & Howell 7 platelets 40,000 Platelets 180,000
120	♀	53	Thrombocytopenic purpura	4+	1000+		50 drops t. d. 1 wk.	4+	000+		Died platelets 40,000
745	♀	17	Thrombocytopenic purpura	4+	110	670	10 drops t.i.d. and 3 blood transfusions	0	90	180	Splenectomy platelets rose from 70,000 to 130,000 before opera- tion recovery

TABLE XV—MISCELLANEOUS

Case number	Sex and color	Age	Diagnosis	Bleeding	Boggs	Duke	Ivy	Viosterol	After viosterol			Result
									Bleeding	Duke	Ivy	
140	♀	35	Hemophilia	4+		150	300	30 drops t.i.d. 1 wk + calcium lactate + heparin 30 drops t.i.d. 1 wk + calcium lactate + heparin 30 drops t.i.d. 1 wk + calcium lactate + heparin 30 drops t.i.d. 1 wk + calcium lactate + heparin	3+ 1+ 1+ 1+	130 90 130 170	310 250 240 410	Steadily worse Howell, 25 min
9	♂	30	Dermatographia	±		80	30	30 drops t. d. 1 wk. 30 drops t.i.d. 1 wk. 30 drops t.i.d. 3 wks	0 0 0	30 50 50	170 60 90	No improvement, had attack of hives under treatment
13	♂	20	Normal (threshold)	“See mal” 0	45%	240	370	30 drops t.i.d. 5 days	0	100	40	Satisfactory
6	♂	21	Normal (threshold)	+	5	80	240	30 drops t.i.d. 5 days	0	80	120	Satisfactory
17	♂	23	Normal (threshold)	0	4	50	230	30 drops t.i.d. 5 days	0	60	100	Satisfactory
18	♂	22	Normal (threshold)	±	6	70	250	30 drops t.i.d. 5 days	±	60	130	Satisfactory
19	♂	21	Normal (threshold)	+	15%	70	190	30 drops t.i.d. 5 days	0	80	100	Satisfactory

determining the coagulation time, nor the ordinary Duke method of determining the bleeding time nor the fibrinogen content nor the prothrombin content nor the total calcium nor the sedimentation rate is reliable.

Among many modifications of the Duke test and other tests presumed to determine the bleeding tendency the only one which we found to be reliable in cases of hepatic deficiency was an application of the Duke method after

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TABLE XII—LEUCEMIAS

Case	Sex	Age	Diagnosis	Hb	R	T	Vosterol	After vosterol			Result
								Hb	R	T	
7	♂	54	Myelocytic leucemia	+	100+	100	30 drops t.i.d. wks	4+	1000+	100	Dead, platelets 1,000,000
181	♀	43	Lymphatic leucemia	+	100+	100	30 drops t.i.d. wks + X-ray therapy	+	100	100	Dead, Howell, 7 mm
190	♂	8	Acute leucemia	4+	100+	100	3 drops 30,000X t.i.d. wks	4+	100+	100+	Dead
260	♀	16	Acute leucemia	4+	100+	100	3 drops t.i.d. 1 wk 3 drops 30,000X t.i.d. 3 wks 3 drops 10,000X t.i.d. 3 wks	4+	100 100 100	100+ 100+ 100+	Dead
7	♂	4	Acute leucemia	4+	100+	100	30 drops t. d. 3 wks	4+	100+	100+	Dead, platelets 200,000
18	♀	46	Myelocytic leucemia	1+	100	100	30 drops t.i.d. 3 days	4+	100+	100+	Dead, platelets 300,000
186	♀	2	Myelocytic leucemia	1+	100	100	No vosterol				Dead
188	♀	46	Lymphatic leucemia	+	100	100	No vosterol				Dead

TABLE XIII—SECONDARY ANEMIAS

Case	Sex	Age	Diagnosis	Hb	R	T	Vosterol	After vosterol			Result
								Hb	R	T	
1	♂	16	Secondary anemia	+	100	100	30 drops t.i.d. 4 days	+	100	100	Improved
18	♂	13	Secondary anemia	+	100	100	30 drops t.i.d. 3 days	+	100	100	Improved
6	♂	17	Erythroblastic anemia	1+	100+	100	30 drops t.i.d. wks 30 drops t.i.d. 3 wks 30 drops t.i.d. 3 wks	+	100 100 100	100 100 100	Platelets 600,000 R.B.C. 4,000,000, W.B.C. 12,000
41	♂	1	von Jaksch's anemia	1+	100+	100	30 drops t.i.d. wks	+	100+	100+	Subcut. liver therapy R.B.C. 4,000,000, W.B.C. 12,000, dead
40	♂	61	Neuphritis anemia	1+	100+	100	30 drops t.i.d. 3 days	+	100	100	Dead
42	♂	64	Secondary anemia bleeding gastric-intestinal carcinoma	1+	100	100	30 drops t.i.d. wks	+	100	100	Gastric resection, dead in shock

bleeding tendency. Two were given vosterol one was not all died.

15 Other miscellaneous patients There were 11 miscellaneous patients without jaundice. These included patients with hemophilia, Bant's disease, scurvy, pellagra, tularemia, ascites, etc. (Table XV). Vosterol was given to all patients with a bleeding tendency but there were too few similar cases to warrant conclusions. One patient with dermatographism had no bleeding tendency but was given vosterol to observe its effect. There apparently was no effect. The patient had a severe attack of hives while under treatment.

It is interesting to note that in 5 apparently normal individuals who were found to have a prolonged bleeding time (Table XV) the

bleeding time returned to normal after from 2 to 5 days of vosterol administration.

SUMMARY AND CONCLUSIONS

There is no single method of predicting a bleeding tendency which is applicable to all types of hemorrhagic diatheses. In the various types of bleeding dyscrasias, it is probable that various factors are responsible and that different tests are required to demonstrate the bleeding tendency in each. Thus, in purpura the platelet count, in hemophilia the Howell method of coagulation time determination, are the most reliable methods of predicting a bleeding tendency. In jaundice or in any liver deficiency neither of these methods nor the Biffi nor Bogg nor Lee and White method of

2 Before exploration for probable malignancy in and about the liver the same results apply unless liver damage is too far advanced

3 In medical cases of gall bladder disease or common bile duct stone viosterol therapy is also indicated if the Ivy bleeding time is prolonged. It then has some value but its effect is not as striking as in the surgical cases

4 In catarrhal jaundice viosterol hastens recovery only in case of prolonged bleeding time

5 In cirrhosis of the liver viosterol is indicated in patients with a prolonged Ivy bleeding time and is of value provided the hepatic damage is not too far advanced or too rapid in its progress.

6 In the medical cases of malignancy in and about the liver viosterol has no particular therapeutic value

7 Viosterol was of no demonstrable value in the miscellaneous jaundices due to cardiac decompensation pneumonia, toxic hepatitis, Banti's disease, portal thrombophlebitis etc.

8 Viosterol was of no particular value in the bleeding tendencies resulting from the blood dyscrasias such as pernicious anemia, leucemia secondary anemia hemophilia, etc., nor was its value sufficiently demonstrated in our small series of purpura, scurvy endocarditis and miscellaneous bleeding cases

9 Before tonsillectomy bleeding histories may be checked by bleeding time determinations but our series of positive bleeders was too small to warrant conclusions

10 The data on the relationship of the prolonged Ivy bleeding time and the effects of viosterol to blood chemistry changes will be reported in a separate communication

REFERENCES

- 1 BROUWER, J. C. Treatment of parathyroid tetany and allied conditions with vitamin D. *Western J Surg Obst & Gynec* 1932 40 390
- 2 CRAMER W and DREW A. The effect of light on the organism. *Brit. J Exper Path* 1923, 4 271
- 3 DU PLESSIS, J. Hemorrhage following tonsillectomy. *Clin. Med & Surg.* 1931 38 112
- 4 CRAVENS, J. D. and SCHMIDT, C. S. Further experiments on the rôle played by bile in the absorption of vitamin D in the rat. *Univ. Calif. Pub. in Physiol* 1934, 8 43
- 5 HESS A. F. LEWIS, J. M. and KIRKIN H. Newer aspects of the therapeutics of viosterol. *J. Am. M. Ass.* 1930, 94 1885
- 6 JONES, J. H. RAPAPORT, M. and HODGES H. L. Source of excess calcium in hypercalcemia induced by irradiated ergosterol. *J Biol Chem* 1930 89 647
- 7 KAMINERY J. and DAVIDSON D. L. Effect of oral administration of irradiated ergosterol on calcium concentration of serum in pulmonary tuberculosis. *Am. Rev. Tuberc.* 1930, 22 48.
- 8 KROOKMASS, I. N. The management of hemorrhagic problems in infancy and childhood. *J Am M Ass* 1934, 99 895
- 9 KROOKMASS, I. N., and SAMUEL, E. L. Avitaminosis and blood clotting function. *Am J Dis Child* 1932 43 52
- 10 LOPEZ, VASA. Die Einflüsse verschiedener Behandlungsmethoden auf die Blutstillung. *Arch f klin Chir* 1931 165 375.
- 11 MASHENWALD, O. N. and NUREMEIER, M. Action of ergosterol on calcium of blood serum in chicken. *J Biol Chem.* 1930, 87 415.
- 12 PHILLIPS, R. A. ROBERTSON D. F. CONSON W. C., and IRWIN G. F. The effect of irradiated ergosterol on thrombocytes and the coagulation of the blood. *Ann. Int. Med.* 1934, 4 334.
- 13 RICHARDSON G. C. The rôle of viosterol in pregnancy. *Illinois M. J.* 1931 59 453.
- 14 ROEMER, P. and MARTENSKEI, L. Ergosterol irradiet hypercalcemia en clinique. *Rev. franç. de pediat* 1929 5 573.
- 15 SANFORD H. N. GASTYER, T. H., and WYAT L. Substances involved in the coagulation of the blood of the newborn. *Am J Dis Child* 1932, 43 566.
- 16 SELYE, H. Ueber die Blutgerinnungsbeschleunigende Wirkung des Vigantols. *Klin. Wchnschr.* 1928 7 1891
- 17 SKELLING D. H. Effect of diet of viosterol on tetany and serum calcium of parathyroidectomized rats. *J Biol Chem* 1932 96 215
- 18 SHERBY S. and BAUM, H. Avitaminotische Krankheitsbilder und Thrombozyten mit Berücksichtigung des roten Blutbildes. *Arch f Kinderh.* 1927 80 269
- 19 SIMCOCK, H. A. Calcium deficiencies in pregnancy and its influence upon the child. *Wisconsin M. J.* 1932 31 338.
- 20 WOTZLICKS, E. Die Physiologie und Pathologie der Blutgerinnung. *Ergebn d Physiol* 1929, 28 443

MECHANICS OF THE PHYSICAL SIGNS IN LOWER TRUNK INJURIES

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MOST injuries of the lower trunk involve the soft tissues only are not demonstrable in roentgenograms, and must be studied clinically (10). The diagnosis of the lesions in which roentgenograms are negative is important from a therapeutic standpoint. The various results of trauma call for different treatment and thereby necessitate differential diagnosis. In compensation cases accurate diagnosis is important in order to distinguish between the malingerer and the honest claimant.

This paper is limited to the lower trunk injuries which involve the ischiogluteal bursa, the sciatic nerve, the ligaments and joints of the lumbar spine, the sacrum, the coccyx, and the hip. In all these injuries there is pain on motion of the trunk and of the extremities. To ascertain what the condition is, to differentiate it from hysteria and from malingering we must analyze the pain producing and the pain relieving motions. A specific pain producing motion is usually named after the man who originally described it as a sign of one pathological condition. Thus flexion of the straight leg at the hip joint elicits pain in the dorsum of the thigh in sciatic neuritis, and is called Lasègue's (9) sign. The same motion elicits pain in the sacro-iliac region in sprain of the sacro-iliac ligaments and is then called Goldthwaite's (8) sign. Outward rotation of the semiflexed thigh may be limited and pain ful in lesions of the hip joint and is then called Patrick's or Lagùère's sign. But the Patrick-Lagùère motion may produce pain in sacro-iliac and in lumbar sprain. We have learned that with few exceptions the signs are not pathognomonic. Errors in diagnosis or failure to gauge the extent of the disability frequently are due to a misunderstanding of the physiology of the body motions used in the examination. The purpose of this article is to describe the physiological basis of the examination. A brief review of the pathology is first presented.

Sprain of ligaments. The function of a ligament is to limit motion of a joint. It follows that the ligament must be just long enough to permit the physiological motion and to endure a certain amount of stress when there is any force attempting to exceed the physiological motion of the joint. In contradistinction to muscle tissue, ligaments have a minimal power of elongation. When a force is sufficient to overcome the resistance of the ligaments, there is an injury to the ligamentous tissue which we call a sprain. The longer the ligament the greater is the degree of motion beyond the physiological required to produce sprain. Where the motion between two bones is very small and the connecting ligaments short, the amount of movement beyond the normal required to strain that ligament is very slight. In a ligament like the lumbosacral, where the amount of physiological motion is small, a sprain can be produced by a motion forcing the ligament to stretch as little as an eighth of an inch. If the ligament is long, as in the ankle joint, it permits a wide range of motion and several degrees of motion in excess of the normal are required to injure the ligament. The severity of sprains varies. Some give mild pain for a few minutes only; others give pain for months.

Pathological examination in the early stages of sprain shows tearing of some of the fibers of the ligament, with bleeding, subsequent examinations show the usual stages of inflammation and repair with scar tissue formation. If there is much scar tissue, its contraction results in shortening of the ligament. The shortened ligament will decrease the range of motion which was possible before the injury.

The bases for diagnosis of sprain of a ligament anywhere in the body are: (1) an area of swelling over the ligament; (2) a definitely localized point of tenderness over the ligament; (3) a spasm of the muscles which prevents stress on that ligament; (4) relief of pain when assuming a position which relieves that ligament of stress; (5) production of pain on

assuming a position which puts stress on that ligament.

In back sprains the swelling is sometimes present in the early stages. More often it is absent, because the ligaments are located beneath the muscle and fat tissue, so that the swelling is not perceptible. For the same reason, the tenderness is not as sharply localized as in the case of sprains of the more superficial ligaments of the extremities. The third, fourth, and fifth criteria of ligament sprain are the same in the back as elsewhere, but assume added importance because swelling and tenderness are unreliable signs.

The diagnosis of sprain is incomplete unless it includes a localization of the involved ligament. Sprains of three sets of ligaments of the lower spine produce signs which clearly differentiate them from one another (1) the coccygeal, (2) the sacro-iliac and ilio-lumbar, (3) the lumbar.

Schmorl has established the importance of the intervertebral disks in the pathology of the spine. If the lesion in some traumatic spine injuries is in the intervertebral disks and not in the connecting ligament the important physical signs must be similar. Functionally the disk is an elastic ligament connecting two vertebral bodies. As in sprain of the other intervertebral ligaments, pain is elicited when these two bodies move on one another. The motions causing or relieving pain will be similar to those of sprain of the true ligaments between the two vertebrae.

Ghormley has recently described injury to the cartilage of the articular joints of the spine as a true traumatic arthritis. He believes that the sudden onset of symptoms with "locking" indicates injury to the cartilage. The occasional sudden relief of symptoms on manipulation is also indicative of an intra articular lesion rather than a ligament sprain. Most authorities believe that traumatic arthritis is an exceptional complication.

The controversy as to whether there is any such thing as traumatic subluxation of the sacro-iliac joint has continued for decades sometimes merrily and often acrimoniously. As there is no direct evidence for its existence, I prefer not to use the term subluxation. However there is no doubt that there is a patho-

logical condition following sprain, the signs and symptoms of which are referable to the area of the sacro-iliac joint. In such cases it is found that any motion or position which puts stress on the ligaments of the sacro-iliac joint elicits pain. Any force that puts stress on the ligaments can also produce that minute motion which we know normally exists in this joint. Can the pain be due to sacro-iliac arthritis? Possibly—but motion so minute as to be demonstrable only in the dissected specimen does not elicit pain in any other joint except in fulminating inflammations. That the lesion is localized in the ligaments is the most reasonable hypothesis. Opinion on the pathology may differ. The signs and symptoms constitute a clear cut clinical entity.

It must be remembered that nearly every motion that puts stress on the sacro-iliac ligaments also puts some stress on the ilio-lumbar ligament. The signs and symptoms which we call the sacro-iliac syndrome, may be due to strain of the ilio-lumbar ligament alone or in combination with strain of the sacro-iliac ligaments. The name sacro-ilio-lumbar sprain is more accurate. Nevertheless the name sacro-iliac syndrome for a combination of physical signs has been in use so long that a change in the name is not desirable.

Synovitis and peri arthritis The synovial membrane is a thin sheet of endothelium like cells which invests the inner side of the capsular ligament of all true joints. Direct trauma (a blow) or indirect trauma (excessive stress on the capsular ligament) may produce an aseptic inflammatory process in this membrane. Synovitis frequently is manifested by an exudate in the joint. Usually the exudate is absorbed completely in time and the joint resumes its normal function. In more severe cases, the exudate is fibrinous and the capsular ligament adheres to the joint surfaces resulting in painful and decreased range of motion. As the synovial membrane is intimately connected with the inner side of the capsular ligament it is not possible to have a traumatic synovitis without some injury to the ligament. The ligamentous injury may resolve before the synovial exudate is absorbed so that clinically only the synovitis is of importance. On the other hand, the injury to the capsular ligament

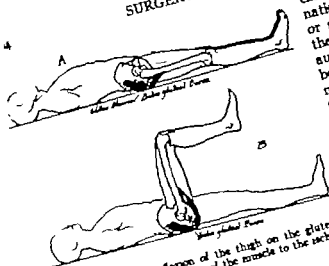


Fig. 1. Effect of flexion of the thigh on the gluteus maximus muscle. The relation of the muscle to the ischio-gluteal bursa is shown.

and the neighboring ligaments may give serious symptoms so that the amount of joint fluid and its absorption are secondary. The inflammatory reaction to trauma in the joint ligaments constitutes a peri-arthritis. In some joints the presence of fluid is easily demonstrated. In the interarticular joints of the vertebrae in the sacro-iliac and the sacrococcygeal joints such demonstration is not possible. In an occasional case of sprain of the hip ligaments a fullness in the groin suggests fluid in the hip joint. In general the only clinical evidence of synovitis in lower trunk injuries is pain when the involved joint is moved. But pain results from the same motion if there is traumatic inflammation of the capsular ligament of that joint. Clinically no distinction can be made between synovitis and peri-arthritis in these joints. The clinical diagnosis of peri-arthritis, therefore, includes the signs and symptoms of any associated synovitis.

The sacrum and coccyx are separated by a fibro-elastic disk analogous to the intervertebral disk of the movable vertebrae. A synovial joint is sometimes present and at times absent. Traumatic coccygodynia is a sprain of the sacrococcygeal ligaments. Had we any means of knowing that there is a true joint space in a particular case it would be called a peri-arthritis.

Post-traumatic neuritis. The pathology and the mechanism of the production of traumatic neuritis are not definitely known. In 36 of 47

cases examined the history or physical examination indicated that it was a sequel of lumbar or sacro-iliac sprain. This is approximately the proportion reported by others (4). Some authors (13) regard it as a radiculitis, and I believe this is correct. I use the term sciatic neuritis in the sense of an organic affection of the sciatic nerve.

Bursitis. Ischiogluteal bursitis is an inflammation of the lining of the bursa lying on the tuberosity of the ischium under the gluteus maximus muscle. The lining membrane is similar to the synovial membrane of a joint. There is usually fluid in the injured bursa.

EXAMINATION

It is unnecessary to discuss the importance of a general examination to exclude non-traumatic lesions. Many visceral diseases give rise to referred pain in the back. The outstanding characteristic of referred pain is that it is not dependent upon motion or posture of the body (16) in sharp contrast with the pain of lower trunk injuries.

The contours of the body the gait the manner of sitting down and of getting on the examining table must be observed. A spastic lateral lumbar muscle spasm. Besides the deformities, such as scoliosis in anatomical deformities, there are functional changes in posture. The patient will avoid pain by holding his body in such a position as to put the least tension or pressure on the injured tissue. Posture may be defined as the unconsciously assumed position of relief. The postures assumed in some of the lesions under discussion are quite characteristic and should be studied in conjunction with the positions of relief and of aggravation found on examination.

The active and passive motions of the trunk and extremities are tested. The important data to ascertain are which motions elicit and which relieve pain at what angle of motion the first pain is elicited and what degree of limitation of motion is present. In examining sprains of some joints, such as the ankle, it is a simple matter to find the motions which elicit pain and those which relieve it. In examining for lower trunk injuries the motions producing relief and aggravation of the pain are more

complicated, as their effects are indirect. In the following descriptions the motions are grouped to aid in understanding their direct and indirect mechanical effects, the sequence is not the one commonly used in a physical examination. In all unilateral lesions a description of a lesion on the left side is given.

COCYGOODYNIA

Inspection and palpation. In sitting, the patient at times puts his weight on one ischial tuberosity, and at times on the other. When he lies on his back on the examining table there is no tendency to flex the knee or hip.

External pressure over the coccyx produces pain. The pain is usually more marked the nearer the tip of the coccyx the pressure is applied because this means greater leverage for movement at the sacrococcygeal joint. On rectal examination some pain is elicited on pressure over the anterior surface of the coccyx. The sacrotuberous ligament may be palpated on each side as it passes laterally from the sacrococcygeal junction to the ischial tuberosity. Pressure on one or both of these ligaments may elicit pain because their lower fibers are continuous with the sacrococcygeal ligaments.

Determination of pain producing motions. Abduction, rotation, or hyperextension of the thighs or hyperextension of the spine have no effect on the coccyx and produce no pain.

With the patient on his back, the examiner gently flexes one thigh on the abdomen. This motion produces pain accurately referred to the coccyx. Flexion of the other thigh elicits the same pain. How does motion at the hip joint affect the region of the coccyx? The gluteus maximus muscle arises from the ilium, sacrum, and coccyx and is inserted in the upper part of the shaft of the femur. Thigh flexion stretches this muscle (Fig. 1) and pulls on the coccyx. This results in pain analogous to that produced by direct pressure over the coccyx. In the standing position flexion of the trunk produces some pain. Flexion of the trunk on the thighs has the same effect on the gluteus maximus as flexion of the thighs on the abdomen and therefore elicits the same pain. Resumption of the erect posture is even more painful. In resuming the erect posture the

gluteus maximus muscle is not only stretched but there is an active contraction of the muscle resulting in increased pull on the coccyx. With the patient sitting trunk flexion has a similar effect on the gluteus maximus muscle but the contraction of the gluteus maximus is not as strong and the pain though present, is less severe.

The reason for the posture is obvious. The patient sits on one tuberosity to avoid direct pressure on the coccyx. He does not flex the thighs because this results in pull on the coccyx.

ISCHIOGLUTEAL BURSITIS (LEFT)

Inspection and palpation. The patient sits with the weight on the right ischial tuberosity never shifting to the left. There may be some tendency to keep the left thigh less flexed than is normal in the sitting position. When the patient lies on the table the legs are kept straight without any tendency toward flexion of the hip or knee.

With the patient lying face down, there is an area of tenderness over the left ischial tuberosity—none on the right. The inflamed ischiogluteal bursa usually contains sufficient fluid so that it is palpable on gentle pressure over the buttock. There is no tenderness over the region of the sacrococcyx and rectal examination is negative.

Determination of pain producing motions. With the patient lying on his back on the examining table flexion of the left thigh elicits pain which is referred to the buttock, but not definitely localized. Flexion of the opposite thigh produces no pain. Rotation or hyperextension of either thigh has no effect.

The ischiogluteal bursa is located between the gluteus maximus muscle and the ischial tuberosity. Flexion of the thigh stretches the gluteus maximus muscle and therefore puts pressure on the tender ischiogluteal bursa (Fig. 1). Rotation and extension of the thigh put no pressure on the bursa, and therefore have no effect.

In the standing and in the sitting position flexion of the trunk produces the same pain as hip flexion because we have the same stretching of the gluteus maximus muscle with the resulting pressure on the ischiogluteal bursa.

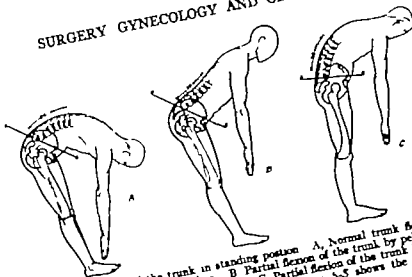


Fig. 2 Flexion of the trunk in standing position. A, Normal trunk flexion by movement of both spine and pelvis. B, Partial flexion of the trunk by pelvic rotation but without movement of the spine. C, Partial flexion of the trunk by spinal motion but without pelvic rotation. The angle of line S-S shows the degree of flexion of the pelvis.

The reason for putting the weight on the affected side in sitting is because of the tenderness of the bursa located directly on the ischial tuberosity. The patient does not flex the left thigh completely because complete flexion stretches the gluteus maximus muscle.

MECHANICS OF NORMAL MOTIONS OF THE TRUNK

Trunk flexion is composed of two simultaneous movements: flexion of the spine and flexion of the pelvis (Fig. 2). In flexion of the spine the normal lumbar lordosis disappears, and changes to a gradual, smooth, convex curve (Fig. 2A). In flexion there is very little movement of the thoracic spine; practically all of the motion taking place in the lumbar portion of the spine. The amount of motion in the lumbar spine can be determined more accurately with a tape as described by McKen- drick. A horizontal line is drawn across the eleventh thoracic vertebra, and a parallel line across the first sacral vertebra. With full lumbar spine flexion the distance between these two lines is increased more than 6 centimeters.

Flexion of the pelvis takes place at the hip joint. As part of the pelvis is below the pivot of motion this movement may be more accurately described as a forward rotation of the pelvis; the axis of rotation is a line connecting the two acetabula. In backward movement of the trunk (extension) the pelvis moves in

the opposite direction and the motion is called backward rotation of the pelvis.

Flexion of the spine and forward rotation of the pelvis contribute about equally to complete trunk flexion. The pelvis can be rotated forward without any motion of the spine (Fig. 2B) resulting in a partial flexion of the trunk. The absence of spinal movement may be voluntary; it may be due to pain on spinal movement or it may be the result of ankylosis of the spine. Partial trunk flexion may be effected by flexion of the spine alone (Fig. 2C). The absence of forward rotation of the pelvis may be due to ankylosis of one or both hips or to pain on forward rotation of the pelvis as in peri-arthritis of the hip joint. We have seen that forward rotation of the pelvis, by stretching the gluteus maximus muscle, produces some pain in ischiogluteal bursitis and in coccygodynia. There may be a tendency to limit pelvic rotation in these two conditions, but there will be no limitation in flexion of the spine.

In every active motion there are two factors—the contraction of one muscle (or group) and the associated relaxation of its antagonist. The normal range of motion, whether passive or active, is usually limited by the structure of the joint surfaces and by the length of the joint ligaments. Some motions are limited by the length of the muscle antagonist. With the patient on his back, passive flexion of the

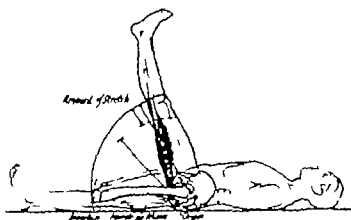


Fig. 3. Showing the stretching of the hamstring muscles by flexion of one leg. The dotted arc is the arc which would be described by the hamstring muscles if they were not forced to stretch. The solid arc is that described by the points of bony attachment of the muscles. The distance between the two arcs at any point is the amount the muscle must be stretched when the leg is flexed to that point.

straight leg on the abdomen is limited to 90 degrees by the normal hamstring muscles. As the examiner flexes the patient's straight leg the distance between the attachment and insertion of the hamstring muscle must increase (Fig. 3). To visualize this fact we must remember that in flexion the leg revolves with the head of the femur as a pivotal center. The hamstring muscles revolve with their point of origin on the tuberosity of the ischium as a center. Imagine the hamstring muscles detached from their insertion on the upper part of the tibia and fibula. If the leg and the detached muscle are revolved together the free ends of the muscles because their pivotal center is posterior to that of the femur describe an arc proximal to the arc described by the heads of the tibia and fibula as shown in Figure 3. With increasing flexion, there must be an increasing stretching of the muscle, if it is to extend to its point of attachment. When the straight leg has been flexed 90 degrees the limit of elasticity has been reached. Any attempt to flex the straight leg beyond the limit of elasticity of the hamstring muscles produces muscle pain referred to the dorsum of the thigh. This movement tests the elasticity of the hamstring muscle. With the straight leg flexed as shown in Figure 3 the hamstring muscle can be relaxed by bending the leg at the knee joint (Fig. 4) because this brings the origin and the insertion of the mus-

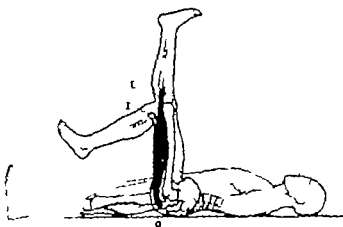


Fig. 4. Showing the decrease in distance from the origin, *O*, of the hamstring muscles to insertion, *I*, on flexion of the knee joint with resulting relaxation of the hamstring muscles.

cle closer together. The thigh can now be flexed completely on the abdomen.

Just as the hamstring muscles limit elevation of the leg when the patient is lying down, so they limit forward rotation of the pelvis in the standing position. Flexion of the knee joint relaxes the hamstring muscles and makes greater pelvic rotation possible. If, however, pelvic rotation is limited by disease of the hip joint, the relaxation of the hamstrings will have no effect.

With one leg in the same position as in Figure 3 the hamstrings could also be relaxed by forward motion of the point of origin of the muscles on the ischium. This means a backward rotation of the pelvis. But with the right leg straight on the examining table the iliofemoral ligament of the right hip is taut and permits only slight backward rotation of the pelvis. When the examiner flexes both legs at the hip as in Figure 5 the hamstrings can pull the ischium forward. Therefore a greater degree of flexion of the legs on the abdomen is attainable when the legs are flexed simultaneously than when one leg is flexed alone. The amount of movement at the hip joints is the same in the 2 cases but with simultaneous leg flexion the whole pelvis rotates backward. In this case the pull of a muscle causes motion in a part not directly moved by the examiner. In motions other than straight leg raising such indirect movement is seldom due to muscle pull but to ligament pull. When a muscle is not spastic or

shortened by disease, it stretches sufficiently to permit as much motion as the length of the ligaments will permit.

The sacrum is part of the pelvis. Backward rotation of the pelvis means a similar motion of the sacrum. This produces a movement of the lumbar spine. The normal concave lumbar curve is first flattened and then becomes convex (Fig. 5). This movement can be demonstrated by the examiner slipping one hand under the concavity of the lumbar spine as the patient lies on his back. When the two legs are flexed at the hip he will feel the pressure of the patient's back as the concavity disappears and the back is flattened. In a preceding paragraph it was shown that but little pelvic motion is possible if the examiner raises one leg alone. It follows that movement of the lumbar vertebrae occurs only when both legs are raised simultaneously. The longitudinal lumbar muscles do not take any part in this motion; they are passively stretched. Normally they are sufficiently elastic so that the vertebrae can move as far as the structure of the ligaments and bones will allow. The sacrum and the lumbar vertebrae are connected to one another by numerous ligaments. As soon as the lumbo-sacral ligaments are a pull on the lumbo-sacral ligaments. As rotation increases the pull is transmitted through the connecting ligaments to the upper lumbar spine. This explains the finding that in lumbosacral sprains pain is elicited on moderate elevation of both legs and by increasing the amount of elevation pain is elicited in sprains of the higher lumbar ligaments.

When we speak of motion of the pelvis it must be remembered that though it moves as one piece the pelvis is not a solid bone. It is composed of three bones: the right and the left innominate bones being united to the sacrum by powerful ligaments. In the erect position most of the weight of the trunk falls on the sacrum and is transmitted through the sacro-iliac ligaments and the innominate bones to the lower extremities. If the sacro-iliac ligaments are strained pain will be felt in the area of the joints in the normal standing position. Although there is some cartilaginous and bony connection between the sacrum

and the ilium the sacro-iliac articulation has a joint space and a minute amount of motion in the joint can be demonstrated in the cadaver. A force exerted through the pelvis (from the trunk to the extremities or from the extremities to the trunk) must be transmitted through the sacro-iliac ligaments. Any motion which tends to rotate the pelvis backward or forward must result in some stress on these ligaments.

In the standing position on flexion of the trunk the pull of the hamstring muscles on the ischial tuberosities tends to pull the pelvis backward. The weight of the trunk exerts a forward stress on the upper sacrum thus tending to rotate the pelvis forward. The resultant of these two opposing forces is a torsion stress on every part of the pelvic ring between the ischium and the sacrum. This ring is composed of bone except at the sacro-iliac joints and the symphysis, and, if the ligaments are sensitive to pull marked pain will result.

With the patient lying prone on the table flexion of the knee stretches the rectus femoris muscle. The origin of this muscle is on the anterior spine of the ilium. The muscle pull tends to rotate the pelvis forward. The stress of the motion is transmitted through the sacro-iliac ligaments to the sacrum and through the lumbosacral ligaments to the lower spine. This movement therefore elicits pain in sprain of either of these ligaments but puts no strain on the sciatic nerve, the ischio-gluteal bursa, or the coccyx.

With the patient again on his back, the heel is placed on the opposite patella, and the thigh is rotated outward and abducted (Fig. 6). In arthritis of the hip joint pain will be elicited because of the movement in the joint. This motion stretches the psoas magnus muscle which takes its origin from the bodies and the transverse processes of the five lumbar vertebrae and is inserted into the lesser trochanter of the femur. By muscle pull on the lumbar vertebrae, slight motion of the vertebrae is produced putting some stress on the intervertebral ligaments. When abduction is complete the hip ligaments are under tension and the pelvis is rotated around its vertical axis (circumduction). This rotary

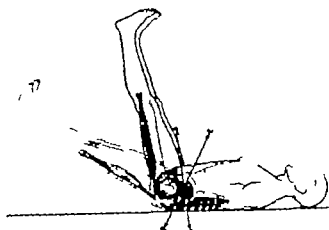


Fig. 5 The hamstring muscles rotate the pelvis backward to the position shown in solid color. This pelvic rotation flattens the lumbar curve (which is the equivalent of flexion of the lumbar spine). Backward rotation of the pelvis brings the origin of the hamstrings forward thus relaxing the hamstring muscles and permitting greater flexion of the thighs on the abdomen. The arrows pass through the anterior superior spine and the posterior superior spine of the pelvis. S-S First position S-S after flexion of legs with rotation of the pelvis

stress is transmitted through the sacro-iliac ligaments to the sacrum and through the lumbosacral ligaments to the lumbar spine. If any of these ligaments are sensitive, pain will be elicited. This motion puts no stress on the sciatic nerve or on the coccyx.

Let us return to a consideration of stress on sacro-iliac ligaments. With the patient lying face down the knee is raised 12 centimeters from the table. This is approximately the limit of hyperextension at the hip joint and on attempting further motion the stress is transmitted through the hip ligaments to the pelvis. The sacro-iliac ligaments of the same side feel the stress first. It is then transmitted through the sacro-iliac ligament of the same side, via the sacrum to the sacro-iliac ligament of the opposite side. Pain on this motion therefore is elicited on the opposite side, if the opposite sacro-iliac ligament is sensitive.

The patient then lies on the left side with the legs straight, and the examiner hyperextends the right thigh. Stress is felt in the opposite sacro-iliac ligament, but the stress is dissipated by motion of the pelvis with associated increase of the lumbar lordosis. This motion of the lumbar spine is of course transmitted through the lumbar ligaments. If the left leg instead of being straight on the

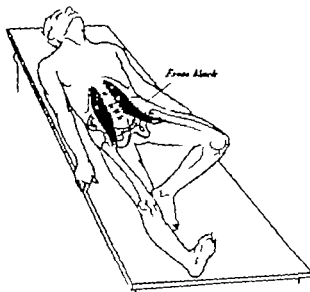


Fig. 6 The left heel is on the patella of the opposite leg. Outward rotation and abduction of the thigh is done by depressing the left knee. The resulting stretch of the psoas major muscle is shown.

table, is completely flexed at the hip and knee, motion of the pelvis is prevented. The stress of the motion cannot be translated into the movement of the pelvis but is concentrated on the sacro-iliac ligaments of both sides. In this position therefore sacro-iliac pain will be more acute and lumbosacral pain will be mild. When the leg is extended and pelvic motion is possible sacro-iliac pain will be mild while lumbar ligament sprain will elicit marked pain.

LESION OF THE HIP JOINT

Inspection and palpation The patient sits with his weight on the right ischial tuberosity. He sits near the forward part of the chair so that the left hip is slightly flexed but not at a right angle. The posture when lying on the examining table is quite characteristic—the left thigh slightly flexed and everted and the knee slightly bent. Occasionally a slight fullness is noticed below the middle of Poupert's ligament. There may be tenderness at this site. With the left leg straight a blow on the heel may produce pain in the region of the hip joint, this is a valuable sign but seldom present in traumatic lesions.

Determination of pain producing motions With the patient lying on his back, the straight leg of the affected side is rotated outward. This movement elicits pain a sign absent in any of the other conditions with

which we are dealing. This movement stretches the anterior hip ligaments and the anterior portion of the hip capsule. There is not sufficient leverage for the force of this motion to be transmitted to any other joints or structures.

and knee are pressed against the abdomen the pelvis cannot rotate forward and the full force of hyperextension of the left thigh is felt in the ligaments of the left hip.

Although slight flexion and outward rotation is the position of relief assumed by the patient there is pain when flexion with outward rotation is carried further. This is tested by putting the heel of the affected leg on the opposite patella and pressing the knee outward (Patrick Lagure sign). This motion produces pain in peri arthritis of the hip in the same manner as rotation of the straight leg, except that, the force being very much more marked it is positive in cases where the stress of the outward rotation of the straight leg is not sufficient to produce pain. The force of this motion is sufficient to be transmitted to the whole of the pelvis and may produce pain in other conditions besides lesions of the hip joint.

Lesions of the hip joint are often associated with spasm of the psoas magnus muscle. The muscle is stretched by the movement just tested—outward rotation and abduction of the semiflexed thigh (Fig. 6). When this muscle is spastic the range of this movement will be decidedly decreased and painful. This will be because any spastic muscle will not permit the same amount of stretching that the normal relaxed muscle permits. Stretching of any spastic muscle produces pain. Limitation of the range of outward rotation of the psoas flexed thigh is, therefore, indicative of psoas spasm. Psoas spasm however is not diagnostic of lesions of the hip joint. It occurs also in sacro-iliac and lumbar sprains.

The patient now lies on the right (unaffected side) with the right leg straight. When the examiner hyperextends the left thigh, mild pain is produced. The right thigh and leg are now flexed against the abdomen and the left leg again hyperextended. More intense pain is now elicited. This difference in degree of reaction is due to the fact that when the right leg is straight the pull on the anterior ligaments of the left hip produces a forward rotation of the pelvis, thus changing some stress into motion. When the right thigh

The reason for the posture assumed is that hyperextension or marked flexion or marked eversion of the thigh each put stress on the hip ligaments and the position of relief is therefore a position of slight flexion and slight eversion. In sitting this can be done only by putting the weight on the opposite ischial tuberosity.

SPRAIN OF THE LUMBAR SPINE

Inspection and palpation. The normal lumbar lordosis is usually increased especially in the acute stages with lumbar muscle spasm. In the chronic cases the curve may be flattened. There is no tilting of the spine but a mild lumbar scoliosis may be found with unilateral muscle spasm. The marked scoliosis found in sacro-iliac sprain and in acute neuritis is never present.

In the acute stages the muscles on one or both sides of the lumbar spine may be prominent, firm on touch and the skin over the muscles may be very tender. Because of this diffuse tenderness, the pain elicited by pressure over the involved ligament may be masked. In the less acute stages the examiner may elicit tenderness to deep pressure at the sacrolumbar joint or between any two of the lumbar vertebrae. Often the tenderness is localized to one side of the midline indicating that the lesion is in one of the paired ligaments of the lumbar spine. The localization of the tenderness does not vary in the course of the examination. Variable tenderness suggests malignancy or 'neuritic spine' (s).

Determination of pain producing motions. In lesions of the lumbar spine, pain is elicited when the patient assumes any position which

produces motion of the lumbar vertebrae or at the lumbosacral joint because any such motion puts stress on the ligaments. The articular capsules and the ligaments of the bodies and of the arches form a complicated system. It may not be possible to discover which of these ligaments is involved in an individual case. The sprain is often in one of the paired ligaments so that the signs are more marked on one side. However any motion which produces stress on the ligaments of one side will affect those of the opposite side to some extent. The pain on the two sides differs in intensity but not in the type of motion which produces it.

With the patient sitting on a stool, lateral bending of the trunk produces some pain in the lumbar region. Lateral bending is in large part a movement of the lumbar vertebrae, and the stress is felt in the ligaments connecting the vertebrae.

With the patient still sitting on a stool, the examiner grasps the shoulders of the patient and rotates the trunk. Rotation is a movement of the thoracic and cervical vertebrae, and little stress is felt in the lumbar vertebrae until partial rotation has taken place. This motion is therefore painful only in the second half of its range.

Both flexion and extension of the trunk are painful because this is, in part, a movement of the lumbar spine. Full flexion or extension may not be possible because of pain. In flexion of the spine the first movement is at the lumbosacral joint, with lesions of the ligaments connecting the fifth lumbar with the sacrum the pain is therefore felt on very slight motion. With increasing flexion of the spine the fourth then the third, second, and first lumbar vertebrae take part. With lesions higher up, therefore the pain is felt on increasing flexion. The higher the ligaments involved the greater the amount of flexion before pain is produced.

Extension of the spine is examined with the patient prone on the table. The two thighs are simultaneously passively hyperextended. This produces a forward rotation of the pelvis, the stress falling first on the lumbosacral joint. As the thighs are raised more, the stress falls on the ligaments of the

upper lumbar vertebrae. If hyperextension is done by raising the upper trunk instead of the thighs, the stress falls first on the uppermost lumbar ligaments and only with greater extension on the lumbosacral joint. Therefore, when slight extension of the thighs produces pain (lumbosacral sprain) marked extension of the upper trunk is necessary to produce the same reaction. In lesions of the upper lumbar vertebrae, marked extension of the thighs or else slight extension of the trunk are required to produce pain.

When the patient lies on his back and the two legs, with knees straight are raised simultaneously, the motion during the first 20 degrees is a simple movement at the hip joint. With increasing flexion the pelvis rotates backward (Fig 5). The pelvis moves as one piece and this backward rotation of the pelvis means that the sacrum is rotating in the same direction and pulling on the lumbosacral ligaments. If there is a strain of this ligament there will be pain on this motion. With increased backward rotation of the sacrum there is a flattening of the normal lumbar lordosis. The movement of the lumbar vertebrae is analogous to that which takes place in flexion of the lumbar spine. Flexion of the thighs therefore, produces pain in sprain of any of the lumbar ligaments. Moderate flexion will produce pain in lumbosacral sprain. Increasing flexion produces pain in sprain of the ligaments of the higher lumbar vertebrae.

Flexion of the thighs produces pain in the lumbar region only in so far as this position produces backward rotation of the pelvis. There is only slight rotation of the pelvis on flexion of the thighs with the knees bent. When the legs are straight more marked pelvic rotation occurs because of the pull of the hamstring muscles on the ischia. When the examiner's hand is placed beneath the upper part of the sacrum he can determine that the pain is never elicited before the thigh flexion causes some backward rotation of the sacrum. Pain due to rotation of the pelvis is the distinguishing feature of lumbar lesions.

The origin of the pain can be checked by another test. When the patient is lying on the left side with the left knee and hip held in flexion, hyperextension of the right thigh elicits

its but mild pain. With the left leg extended in the anatomical position hyperextension of the right thigh produces much more pain. When the thigh and leg are flexed the pelvis is fixed and the force is not easily transmitted to the lumbar spine but when the left leg is extended the force is quickly translated into motion of the lumbar spine. The results in lumbar sprain are the reverse of those obtained in sacro-iliac sprain.

Outward rotation of the semiflexed thigh will produce pain if the motion is carried far enough because this motion causes a circumduction of the pelvis (rotation on its vertical axis) with its inevitably associated rotation of the lumbar spine. Pain on this motion may also be the result of pull of the psoas magnus muscle on the lumbar vertebra (Fig 6).

MUSCLE SPASM

In the acute stages of lumbar sprain there is spasm of the lumbar muscles. Usually bilateral it may be unilateral. There may be no spasm with the patient at rest but it appears only when the patient flexes the spine or (with the patient on his back) the examiner flexes the thighs.

The normal range of motion of the skeleton is partly dependent on the relaxation of an antagonistic set of muscles. Passive or active motion will be less than normal if the antagonists are shortened by disease or by reflex contraction. This decrease in the range of motion or limitation of motion as it is usually called is important in the diagnosis of trunk injuries. A patient may limit a pain producing motion even though no muscle rigidity is present. This voluntary limitation may be overcome by reassurance and gentleness on manipulation. Voluntary contraction is rarely limited to one specific group of the muscles of the trunk or limb on motion. It may appear after the motion is completed. Involuntary muscle spasm is limited to specific muscle groups, is often (not always) found at rest as well as on motion and is present or develops during motion and not after the motion is completed. Voluntary contraction is not usually a sign of malingering if it occurs with a pain producing motion. If the same reaction occurs with a

motion which should not be accompanied by pain we may conclude that the patient is malingering.

Motion which stretches a spastic muscle will be painful and the range of that motion will be limited. The determination of which motions produce pain and are limited because of muscle spasm is essential for two reasons. First, the presence of spasm in specific muscle groups and its absence in other groups is indicative of certain underlying lesions, are and these underlying lesions, themselves, are diagnosed largely on the basis of the tenderness and painful motions to which they give rise. The motion limited by a spastic muscle is always one which would cause pain in the underlying lesion if the motion were carried to its full range. The limitation of motion and the pain of muscle spasm are always evident before pain is produced at the site of the lesion itself. The pain of muscle spasm is referred to the site of the muscle and not to the site of the lesion.

Lumbar muscle spasm. The sacrospinalis muscle group is chiefly involved in this spasm but it seems probable that the multifidus, the semispinalis, and the small intervertebral muscles also take part. The sacrospinalis muscle is attached below to the sacrum, to the spinous and transverse processes of the lumbar vertebrae, to the lumbar fascia and the eleventh and twelfth ribs. It lies in a groove on each side of the vertebral column. It splits into various groups which are attached above to the lower nine ribs, to the spine, and to the transverse processes of the upper thoracic vertebrae. Some one fasciculus being attached to every bone of the trunk, there is hardly a motion of the trunk which does not stretch part of this extensive muscle group. In extreme spasm, deep breathing may be limited by the fibers attached to the ribs.

Palpation. The patient lies prone on the examining table. The hard sharply outlined mass of a very spastic muscle is easily palpated but it is necessary to train the fingers to feel lesser degrees of spasm. Spastic muscle is always tender. The extent of the muscle involved as well as degree of spasticity varies with the severity of the lesion. In mild cases only a segment may be affected.

Determination of pain producing limited motions due to muscle spasm. In lumbar spasm many motions may be limited, only the more important ones commonly used in diagnosis will be described. Flexion of the trunk is limited in so far as this is a movement of the spine but that part of the movement which is due to forward pelvic rotation is not limited. The limitation of trunk flexion is entirely due to limitation of intervertebral movement. The limitation of lumbar spine movement is the same in sitting as in standing. It follows that the difference between flexion of the trunk in the standing, and in the sitting posture is the same as in the normal individual. Not alone are movements between the lumbar vertebrae limited but also movements between the fifth lumbar and sacrum because the sacrospinalis muscle is attached to the sacrum. Any backward rotation of the pelvis will stretch that muscle. This is the effect of flexion of the two thighs when the patient is lying flat on his back (Fig 5). The backward rotation of the pelvis is more marked if there is forward pull on the ischia by the hamstring muscles, even though there is no hamstring spasm. We have discussed the fact that hamstring muscle pull is greater when the knees are straight. The pain and limitation of hip flexion will therefore, be greater when the knee is straight and will be relieved when the knee is flexed. Because the pelvic rotation is very slight before the end of the first half of trunk flexion the limitation is rarely as marked as in hamstring spasm. As the limitation is due to an effect on the lumbar muscles the pain will be referred to the lumbar region instead of to the dorsum of the thigh. Hamstring tension is somewhat relieved on backward rotation of the pelvis but this motion increases the tension on the lumbar muscles. It has previously been stated that raising the two legs simultaneously produces more pelvic rotation than raising one at a time. In lumbar spasm therefore raising both legs is more painful and limited than raising one leg at a time—in contrast to the result in hamstring spasm.

In unilateral spasm the pain will be present on the affected side only. Spasm of the hamstring muscles is occasionally found in lumbar

lesions but because it is much more common with sacro-iliac sprain and sciatic neuritis it will be described later.

PSOAS MUSCLE SPASM

The psoas muscle may be spastic in lumbar and sacro-iliac ligament sprain as well as in hip conditions. The muscle lies too deep for palpation, spasticity must be determined entirely by indirect means. It is attached above, to the five lumbar vertebrae and is inserted below into the lesser trochanter of the femur.

Determination of pain producing limited motion. With the patient on his back the heel of one foot is placed on the opposite patella. The thigh is then rotated outward and abducted (Fig 6) thus stretching the psoas muscle. When the psoas is spastic this movement elicits pain referred to the pelvic region and the range of the motion is limited.

SACRO-ILIAC SPRAIN (LEFT)

Inspection and palpation. The spine is tilted forward and usually to the right, that is toward the unaffected side. The normal lumbar lordosis is flattened. If scoliosis is present the convexity is to the left (homologous scoliosis). In standing the weight is on the right leg the left knee is slightly bent. There is no eversion of the leg at the hip. Standing is tiring and the patient prefers to sit, putting the weight on the right ischial tuberosity.

The left lumbar muscle may be spastic, occasionally there is spasticity of both lumbar muscles and rarely of the opposite side alone. There is tenderness to the left of the fifth lumbar vertebra and along the posterior border of the ilium, most marked near the posterior inferior spine.

Determination of pain producing motions. The patient lies flat on his back. Flexion of the left thigh with the knee bent, produces a moderate rotation of the pelvis by pull on the hamstring and gluteal muscles. As the pull is on one half of the pelvis while the other half is fixed by the position of the right thigh, the movement produces a rotary stress on the sacro-iliac joint ligaments. When flexion is complete there is some rotary movement of the pelvis on the lumbar spine. The ilio-

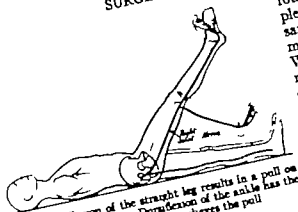


Fig 7 Flexion of the straight leg results in a pull on the sciatic nerve trunk. Dorsiflexion of the ankle has the same effect. Flexion at the knee relieves the pull.

lumbar ligament is put under stress by this motion. Thigh flexion produces some pain in all sacro-illolumbar conditions.

When the thigh is flexed with the knee straight, the hamstring muscles come into action at a much lesser angle of thigh flexion. The straight leg is flexed to the point at which moderate pain is produced. In this position bending the knee at right angles results in sudden cessation of pull on the pelvis by the hamstring muscles, and further flexion without pain is possible.

The patient now turns to lie face downward. Hyperextension of the left thigh elicits pain in the left sacro-illiac area. Hyperextension of the right thigh produces no pain at first and on more marked extension pain is produced on the opposite side. Contralateral pain on hyperextension is characteristic of sacro-illiac disease. It was first described by Gaenslen.

With the patient again on his back, the heel of the left foot is placed on the right patella (Fig 6) and the left knee joint pressed downward and outward (i.e. outward rotation of the semiflexed thigh). When this motion is complete there is pressure by the femur on the left half of the pelvis with a shearing stress on the sacro-illiac joint. This motion therefore elicits pain in sacro-illiac ligament sprain. Similar action on the right side will elicit no pain or mild pain referred to left sacro-illiac area.

With the patient lying on the right side the left thigh is hyperextended. This produces stress on the sacro-illiac ligaments but before it can become very great the pelvis

rotates forward. If the pelvis is fixed by complete flexion on the right hip and knee, the same hyperextension produces much more marked stress on the sacro-illiac ligaments. With the patient lying on the left side these maneuvers are repeated. When strain is put on the right sacro-illiac joint there is no pain but when the pelvis is fixed sufficient stress is transmitted to the opposite sacro-illiac area to produce pain.

In the sitting position, flexion of the trunk is painful because the pull of the flexed spine is transmitted through the sacrum to the sprained sacro-illiac ligament. Because of this pain the patient may limit the flexion of the lumbar spine but that part of trunk flexion due to pelvic rotation is not limited.

In the standing position, trunk flexion is more painful than in sitting. In both positions we have the weight of the flexed spine tending to rotate the sacrum forward. In standing with legs straight, we have a second factor—the hamstring muscle pull preventing the full rotation of the pelvis forward. These two forces, one acting on each side of the sacro-illiac joint but in opposite directions, produce a marked stress on the sacro-illiac ligament. The pain and limitation of trunk flexion is, therefore, more marked in standing than in sitting.

Sacro-illiac sprain may be associated with spasm of one or more of three groups of muscles—the lumbar the psoas magnus, and the hamstring muscles.

HAMSTRING SPASM

Inspection and palpation. Spasm of the hamstring muscles cannot be palpated at rest—it is always latent. Examination of the patient as he rests on the table is negative. *Determination of pain producing limited motions.* The patient lies on his back on the examining table. The examiner places his hand under the calf and slowly flexes the hip, the leg being kept straight. The examiner's other hand is on the posterior surface of the thigh to palpate the hamstring muscles. This movement (Fig 3) stretches these muscles and will bring out any latent spasticity. The spasm can be palpated is painful and limits the motion. If the normal muscle is stretched

TABLE I

Lesion	may be associated with	spasm of
Spasm of the lumbar spine	Lumbar muscles	
	Hamstring muscles	
Spasm of the sacro-lilac area	Lumbar muscles	
	Hamstring muscles	
	Psoas major muscle	
	Psoas minor muscle	
Spasm of the hip	Hamstring muscles	
Sciatic neuritis		
Lumbosacral neuritis		
Coccygodynia		

to its physiological limit at ninety degree flexion of the straight leg, it follows that a spastic muscle will permit less than this normal range of motion. The limitation and pain will be relieved on flexion of the knee for the reasons discussed in the section on "Mechanics of Normal Motion." The difference in the range of motion with the knee flexed and with the knee extended must be more marked when the hamstring muscles are spastic. All other motions that are ordinarily limited when the normal hamstring muscles have been stretched to a maximum will be much more limited when the muscle is spastic. Thus, in the standing position flexion of the trunk, in so far as pelvic rotation is a factor, will be limited and elicit pain in the dorsum of the thigh. Complete flexion is possible when the knees are bent.

In the sitting position because the knees are at right angles there is no limitation in flexion of the trunk. The difference between the range of trunk flexion in standing and in sitting is striking.

A summary of the occurrence and symptoms of muscle spasm may be helpful at this point. In the left hand column of Table I the common lower trunk injuries are listed and on the right the muscles which may be spastic during the acute stages of each lesion. In Table II the motions are listed which are limited and painful in the presence of spasm of each of the three muscle groups.

POST TRAUMATIC SCIATIC NEURITIS (LEFT)

Inspection and palpation. Tilting of the spine is less common than in sacro-lilac conditions, when present it is to the left. Lumbar scoliosis first described by Charcot and Babin ski (1), is found in 80 per cent of cases, the convexity is to the right (contralateral scoliosis). The patient tends to keep the leg everted, the knee bent, and the foot extended

TABLE II

Motion which is limited and painful in spasm of	Hamstring m.	Lumbar m.	Psoas m.
Standing			
Flexion of trunk			
A. Lumbar spine	+	++++	o
B. Pelvis	++++	+	
Sitting			
Flexion of trunk			
A. Lumbar spine	+	++++	o
B. Pelvis	++	+	o
Lying			
Flexion of thigh, knee straight	++++	++	o
Flexion of thigh, knee bent	++	++	o
Flexion of both thighs, knees straight	+	+++	
Flexion of both thighs, knees bent	+	++	
External rotation of the semiflexed thigh	o	o	++++

In severe cases the hip is flexed as little as possible. The standing position is more comfortable than sitting.

Tenderness of the nerve trunk may be present but is absent in the majority of cases. What is usually mistaken for nerve trunk tenderness is tenderness of the hamstring muscles and muscles of the calf. Atrophy of the thigh and calf muscles is an early and reliable sign. The circumference of the thigh and calf should be compared with the other side.

Determination of pain producing motions. When the patient lies flat on the table the sciatic nerve pursues an almost straight course from its lumbosacral origin to the internal malleolus, underneath which it turns forward to pass to the toes as the plantar nerve. It has been demonstrated on the cadaver (5) that the painful motions in sciatic neuritis are those which produce tension on the nerve roots by stretching the sciatic nerve trunk.

When the patient is on his back, the examiner flexes the left leg at the hip (Fig. 7). Pain is elicited which may be referred anywhere along the course of the nerve. Pull on the nerve by this motion is due to angulation of the nerve at the hip. The main stress is due to pull on the nerve from below the point of this angulation. The mechanics of the main stress is analogous to the mechanics of pull on the hamstring muscles by this motion. On flexion the leg revolves about a center (the acetabulum) which is anterior to the center of motion of the sciatic nerve. The tension on the nerve is immediately and almost completely relieved by flexion of the knee joint. On passive flexion of the thigh, with the knee

bent little or no pain is elicited because the slack of the nerve by knee flexion is usually more than sufficient to compensate for the pull of the angulation at the hip joint. On passive flexion of the right (unaffected) leg no pain is elicited.

Again passively flexing the left leg to the point at which pain is first elicited because the inner dorsiflexes the ankle joint. Acute pain is produced in the course of the sciatic nerve. Dorsiflexion of the ankle joint can have no effect on any of the tissues of the lower trunk except the sciatic nerve. The angle which the nerve turns below the malleolus is increased on dorsiflexion of the ankle joint, thus causing a pull on the nerve trunk. Pain on this motion is one of the few signs which is characteristic of a single lower trunk injury. It was first described by Roussy.

When the straight leg is flexed at the hip abduction and inward rotation relieve the tension on the sciatic nerve because in this position the nerve course is more nearly a straight line. With abduction and inward rotation there is greater range of motion without pain is possible. Adduction and outward rotation have the opposite effect. Flexion of the trunk is painful. That part of the flexion due to motion of the lumbar spine is free but forward rotation of the pelvis elicits pain in sciatic neuritis as the effect on the sciatic nerve is exactly the same as in passive flexion of the straight leg. In sitting, trunk flexion elicits little pain; this motion is comparable to flexion of the thigh with the knee bent.

The posture described under inspection is the position which causes the least pull on the nerve roots—namely eversion at the hip, flexion at the knee, and extension at the ankle joint.

Other physical signs. Physical signs characteristic of nerve lesions may be found such as absent tendo-achilli reflex, anesthesia may be present. Because they so clearly indicate a nerve lesion as distinguished from lesions of other tissues involved in lower trunk injuries, they are of great importance and are never present. In some cases they are transient or are never present. In other cases they persist long after

the pain and disability have disappeared. The pain on specific motion is more reliable than other signs as an index of the disability caused by neuritis.

Hamstring muscle spasm and sciatic neuritis. Hamstring neuritis in the acute stage is often associated with hamstring muscle spasm. The motions painful in the two conditions have many similarities, and the pain in both conditions is referred to the dorsum of the thigh. But hamstring spasm may be due to sacro-iliac and occasionally to lumbar spasm. The spastic muscles always should be palpated before a diagnosis is made. The pain on dorsiflexion of the ankle joint sometimes present in neuritis is a valuable sign. It is never found if the hamstring spasm is due to any lesion other than neuritis. Tenderness of the trunk of the nerve is helpful, but not often found. Most important is the search for signs of the other lesions producing hamstring spasm. The commonest mistake in the diagnosis of lower trunk injuries is to diagnose as sciatic neuritis the hamstring spasm due to sacro-iliac or lumbar strain.

Malingering and exaggeration. Backache is a frequent complaint in compensation cases, and in view of the financial benefits involved, the possibility of malingering must always be considered. A distinction must be made between malingering and exaggeration. When a patient has a long continued back pain and has been told by several physicians—"nothing to be seen, the ache will pass off"—it is not surprising that he grows apprehensive and exaggerates his symptoms when the pain persists. If the physician knows the physical signs it is not difficult to find inconsistencies which are the hall-mark of malingering. There is no single sign which proves malingering; it is the inconsistency of the signs on which that diagnosis is based.

A patient may allege inability to flex the trunk more than a few degrees on standing. When on his back it is found that thigh flexion and pelvis rotation are normal. The findings in the two positions are inconsistent. Even though he had a poker spine he could bend the trunk to a fair extent with normal motion at the hips. He is definitely malingering.

When a patient alleges more marked restriction

tion and pain on flexion of the thigh with knee bent, than in straight leg raising, we know we are dealing with malingering.

I have seen the following signs erroneously described as signs of malingering.

1. With the patient prone on the table, he alleges pain on flexion of the knee. Comment: the flexion of the knee in this position by pull on the rectus femoris, produces a forward rotation of the pelvis. It may therefore, produce pain in the sacro-iliac or lumbar sprain but never in sciatic neuritis or ischio-gluteal bursitis.

2. A patient who keeps his lumbar spine rigid in flexion of the trunk is placed supine on the table on dorsiflexion of the two thighs simultaneously it is found that the lumbar curve can be changed without pain. Comment: when the pain is due to strain on a muscle which has latent spasticity the pain may be present in active flexion of the trunk when standing, and absent with passive motion of the spine when lying down. Sir John Collie describes this as a sign of malingering. It is occasionally found with lumbar muscle spasm and is then no indication of malingering. Failure to flex the spine is not the same as failure to flex the trunk.

3. The presence of exquisite superficial tenderness. Comment: the fact is that exquisite superficial tenderness may be present in the area of any spastic muscle.

SUMMARY

1. Each lower trunk lesion produces pain in a definite combination of motions which is characteristic of that lesion. Supposedly pathognomonic signs are misleading.

2. The physiological principles which account for the elicitation of pain by specific test motions have been described.

3. Each lesion may produce spasm in certain muscles and does not produce spasm of other muscles.

4. The various signs bear definite relationship to one another. By inconsistencies

in these relationships, the diagnosis of malingering can be made.

BIBLIOGRAPHY

1. BARNES, J. Sur une deformation particuliere du tronc causee par la sciaticque. Arch. de neurol. 1888, 15: 1-24.
2. BARKER, A. S. B. Manipulative Surgery. p. 92. London: Constable & Co., 1931.
3. COLLIE, SIR JOHN. Fraud in Medico-legal Practice. P. 305. London: Edward Arnold & Co., 1933.
4. COWAN, JOHN. The relation of sciatica to the sacro-iliac joint. Brit. M. J. 1923, 1: 373-375.
5. DEUTSCH, FRANZ. Ueber die Diagnose der Ischias auf Grund der Proben nach Lasgus, Feuerstein und Bonnet. Wien klin. Wchnschr. 1921, 34: 293-294.
6. GARDINER, F. J. Sacro-iliac arthrodia. J. Am. M. Ass. 1927, 80: 2031-2035.
7. GHEORGHIE, R. E. and KIRKENDALL, B. R. Demonstration of articular facets in lumbosacral backache. Am. J. Roentgenol. 1934, 31: 173-176.
8. GOLDTHWAITE, PAINTER, and OSOOND. Diseases of the Bones and Joints. P. 539. Boston: D. C. Heath and Co., 1909.
9. LASKOWITZ, CH. Considerations sur la Sciaticque. Arch. Gen. de Med. 1864. Reprinted in Etudes Medicales. P. 303. Paris: Asselin et Cie, 1884.
10. LEWY, RAPHAEL. Trauma and the spinal column. Read before the Fifth Industrial Surgical Congress. New York State Dept. of Labor Med. Div. Bull. 1918, No. 13: 13.
11. MCKENDRICK, ARCHIBALD. Back Injuries and Their Significance. Pp. 108-110. Edinburgh: F. & S. Livingstone, 1916.
12. PATRICK, HUGH T. Brachial neuritis and sciatica. J. Am. M. Ass. Dec. 30, 1917, 79: 2176-2179.
13. ROGERS, MARK H. An analysis of 50 cases of sciatica. J. Am. M. Ass., 1917, 68: 425-430.
14. ROBERT, GUSTAVE. Les Manoeuvres dans le Diagnostic des Algies Sciaticques. La Med. 1920, 1: 290-291.
15. SCHWARTZ, C. G. and JUNGKUNST, H. Die gesunde und kranke Wirbelsaule. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1932, Suppl. 43.
16. STEINLEDER, ARTHUR. Diseases and Deformities of the Spine and Thorax. P. 205. St. Louis: The C. V. Mosby Co., 1923.
17. STEINLEDER, F. VON. Die Sehnenreflexe und ihre Bedeutung fuer die Pathologie des Nervensystems. 1893, p. 116.

THE ENERGY BACKGROUND OF THE GENESIS OF GALL STONES AND OF THE PREVENTION OF IMMEDIATE POSTOPERATIVE SHOCK AND OF LATER DIGESTIVE DISTURBANCES¹

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THE conceptions of classical physics were profoundly altered by the researches which followed the discovery of the X-ray. The conceptions of classical physics and biology are now undergoing a profound alteration as the result of researches into the radiant and electric energy of protoplasm.

In Europe following the work of Gurwitsch and others, these new conceptions regarding the rôle of electricity and radiation in the activities of protoplasm have advanced so far that the International Society of Electroradiobiology has been formed with an official journal *Radiobiologie* the first number of which appeared in April 1932.

If we are correct in our assumption—and this assumption is based on experimental evidence—that the organisms of animals and of man are operated by radiant and electric energy and that a mechanism has been set up to render this energy available for adaptive purposes, then on this basis we should expect variations in the relative sizes of the energy units of this mechanism—the brain, thyroid and adrenal sympathetic system according to the adaptive needs of the species, and according to the varying demands of different age periods.

One of the characteristics which separates man from the other mammalia is his incessant activity especially mental and emotional. Wild and domestic animals secure food, procreate play and sleep. Primitive or uncivilized man is relatively inactive. Civilized man however works all day and worries at night. The level of energy expenditure is one of the measures by which we may estimate the level of civilization. Therefore, one would draw the inference that the evolution of man involved the brain and also the gland that governs the rate of metabolism namely the thyroid gland.

With a normal thyroid there is normal brain activity. With a deficient thyroid there is diminished brain activity. With excessive thyroid activity there is excessive brain activity. The thyroid hormone maintains the level of activity of the brain. One would therefore expect the relative sizes of the thyroid, the adrenal sympathetic system, and the brain to vary with the energy characteristics of animals that is, one would expect that the size of the thyroid would increase in proportion to the rate and constancy of demands for energy production while the size and intricacy of the adrenal sympathetic system, on the other hand, would vary with the need for sudden use of that energy (Fig. 1). It would follow that the size of the thyroid in relation to body weight would be greater in man than in other mammals, and that the adrenal glands, as Cannon has shown, being the organs that govern the outbursts of energy would be larger in relation to body weight in the animals that depend on a rushing attack or a swift escape.

Moreover, one would suppose that the nerves and ganglia which are associated with the adrenals would be much more abundant and their arrangement more complicated in animals in the energy group such as the tiger than in animals in the protected group such as the alligator.

Studies in the comparative anatomy of the brain, thyroid and adrenal sympathetic system have shown that these assumptions are well founded in particular as regards the intricacy and size of the adrenal sympathetic system which is large and complicated in lion and tiger (Fig. 2) less so in man whose frontal lobe, however, is most highly developed (Fig. 3) while both the brain and the adrenal sympathetic system are small and uncomplicated in the crocodile and in the alligator (Fig. 4).

(Fig. 4)

¹Presented at the Temple University School of Medicine (on the occasion of the symposium of a portrait of Dr. W. W. Keen in the School by the third and fourth year classes), Philadelphia, Pennsylvania, May 8, 1934.

If the brain, the thyroid gland and the adrenal sympathetic system are thus linked together it would follow that in a state of abnormal activity or what we may term pathological physiology of this great system the whole organism would be affected, with the resultant production in one individual of hyperthyroidism, in another of diabetes in another of peptic ulcer in another of gall stones. None of these originates within the affected organ. The thyroid gland does not originate hyperplasia, hyperplasia is imposed upon the thyroid gland. The stomach does not originate a peptic ulcer the condition within the stomach which produces an ulcer is imposed upon the stomach by influences outside itself. The pancreas does not originate diabetes, diabetes is imposed upon the pancreas and so it is with gall stones: their origin is not within the gall bladder nor within the liver but the condition which produces gall stones is imposed upon the liver by influences outside itself.

That emotion physical exertion—any excess transformation of energy—affects the whole energy system is well known as has been shown by Cannon and ourselves. That such hyperactivity of the adrenal sympathetic system affects the liver has been demonstrated by our histological and biophysical researches.

Twenty four years ago we conducted an extensive histological research to discover what organs and tissues are affected by excess or diminished transformation of energy in the body. In this research a histological examination was made of every organ and tissue in animals which had been subjected to insomnia to fear to physical injury to shock to prolonged anaesthesia to infection. In every case histological changes were observed in three organs and in three organs only the brain the liver and the adrenals. The liver cells lost their differential stainability—they became swollen and oedematous the cytoplasm was vacuolated the nuclei were crenated and the cell membranes were irregular the most marked changes occurring in the cells nearest the periphery of the lobules (Fig. 5). Identical changes were found in the liver cells of patients who had died from infection puerperal eclampsia hyperthyroidism or in any

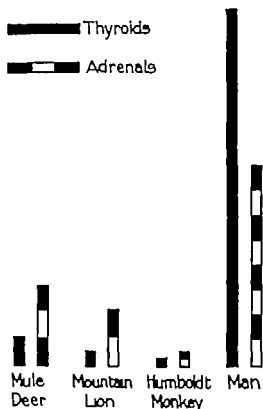


Fig. 1. Comparative sizes of the thyroid and adrenal glands (charted from actual weights)

case in which exhaustion was due to the protraction or intensity of the disease. Later biophysical researches disclosed that, under identical conditions changes took place in the temperature and in the electric conductivity, electric capacity and electric potential of the liver. These experimental facts confirm the clinical deduction that the change in the bile which leads to gall stones is not due to changes in the gall bladder but to changes in the function of the liver cells.

It would follow that one would expect to find the highest incidence of gall stones among races and individuals in whom the energy system is peculiarly active. How is this assumption borne out by known facts regarding the incidence of gall stones? Gall stones are rarely seen in wild animals in which although adequate for attack and defense the adrenal sympathetic system is not subject to prolonged stresses and strains. Dr. Herbert Fox, Pathologist at the Philadelphia Zoological Gardens has reported the finding of gall stones in but 14 of 5,365 autopsies on wild animals in captivity. Gall stones are less common in the lower races of man than in civilized races and

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among civilized races gall stones are less common among peoples who have a negative philosophy. Gall stones are most commonly found in Americans and Europeans less commonly in Asiatics. While gall stone disease is relatively common among Americans and Europeans it is most common among people of the Hebrew and Latin races.

In other words, gall stones occur most frequently in the active aggressive section of the human family, their incidence corresponding roughly to the distribution of hyperthyroidism, peptic ulcer, neurocirculatory asthenia, diabetes, highly emotional temperaments and high scholastic high executive and administrative ability.

Another significant fact is that among humans the incidence of gall stones is higher among females than among males especially among women who have given birth to children.

In pregnancy there is increased metabolism with hypertrophy of the thyroid and of the adrenal glands, there is a gain in weight, nervousness and palpitation are present, the organism is stepped up as in the expression of the emotions, in defense against infection, excessive and fatigue-producing work. Dr. E. L. Walsh, George W. Belcher Research Fellow of the Cleveland Clinic Foundation states that hypercholesterinemia is present in pregnancy. Therefore, since the liver cells are the only source of the bile in pregnancy, are the only source of the bile as in pregnancy, interfered with so profoundly as in pregnancy, the concentration of the bile is changed, and therefore the formation of gall stones is facilitated. But pregnancy itself is not the only reason why a married woman with children is more commonly affected by gall stones than men or non-childbearing women. The married woman has the children and the household and a husband on her hands as well. She is peculiarly subject to restraints and worries and anxieties and emotional strains all of which involve the adrenal sympathetic system and in consequence as we have demonstrated disturb the function of the cells of the liver. To that extent the childbearing woman is more prone to have gall stones than is her husband or the woman who has borne no children.

Any theory that is proposed to account for gall stones must account for all these facts. Our thesis is that the chemical and physical basis of gall stones is laid by changes in the secretion of the biologically active liver cells and not by changes in the sac that holds and concentrates the bile and performs no other function.

Let us consider the means by which the bile carries in solution such large quantities of cholesterol and bile pigment without forming gall stones in every human gall bladder. Dr. A. C. Ivy and Dr. E. L. Walsh and others have demonstrated clearly by their studies of the effect upon human gall stones of placing them in the gall bladder of a dog, and by experiments on the solution of gall stones in vitro, that the outstanding factors that govern the maintenance of the cholesterol and pigment in the gall bladder and ducts are the bile salts and the fatty acids. We may conclude that when these are present in sufficient concentration there apparently will be no formation of gall stones. Therefore when gall stones form they form because there is an insufficient concentration of bile salts and fatty acids or perhaps an excess of cholesterol. We know that in highly developed, high-strung emotional active people and in children bearing women the adrenal sympathetic system is hyperactive. We know that hyperactivity of the adrenal sympathetic system profoundly affects the cells of the liver. We know that when the liver cells are so altered, they will not secrete a normal quantity of bile salts and fatty acids.

A significant fact is that comparatively few of the individuals—animal or human—that have gall stones also have cholecystitis or gall stone colic. Since to per cent of the inhabitants of Europe and America have gall stones, there should be approximately twelve millions of gall bladders which contain gall stones in the American population at this time yet the total number of operations for gall stones and the total number of cases of gall-stone colic are relatively small.

We must offer evidence, therefore, that gall stones are not produced primarily by infection of the gall bladder as is the common belief. If in a hundred thousand cases, gall

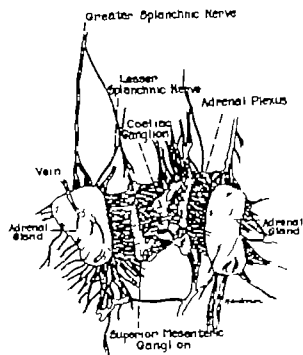


Fig. 2 The adrenal-sympathetic system of the tiger

stones were taken from the gall bladder and replaced by any other foreign body of the same size and weight one might expect the incidence of infection and abscess to be approximately the same as in the case of gall stones in nature. In either case the infection might be due to the local irritation from the foreign body or from the gall stones. The question raised is whether the infection is not the *result* rather than the *cause* of gall stones. That this is the case is attested by the fact that there are at this moment in the United States, approximately twelve million people who have gall stones in their gall bladders and do not know it. Moreover and this is an even more important fact relatively few patients have an infected gall bladder or an abscess in the gall bladder without gall stones.

It is readily to be seen that when there is an interference by gall stones or infection with the free flow of bile in and out of the gall bladder there results an immediate interference with the concentration of the bile salts and fatty acids and to that extent the further formation of gall stones is promoted by the diminished concentration of the solvent bile salts and fatty acids. Thus an infection of the gall bladder by interfering with the concentration of the bile would

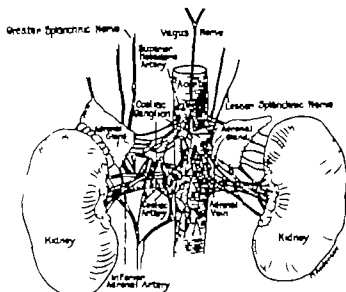


Fig. 3 The adrenal-sympathetic system of man

probably promote the formation of gall stones. We believe however that local infection is more commonly secondary just as in many cases of hyperthyroidism of peptic ulcer of Raynaud's disease of intestinal obstruction there are many secondary effects which arise from the primary cause. Therefore we may think of an infection of the gall bladder as being a complication of stones rather than of stones being a complication of the infection.

In this connection it is pertinent to recall that there was a time following the work of Halsted when it was believed by many pathologists and surgeons that gall stones were commonly due to the presence of typhoid bacilli in the gall bladder. It is now about 30 years since typhoid fever has been practically eliminated as a disease and therefore if this

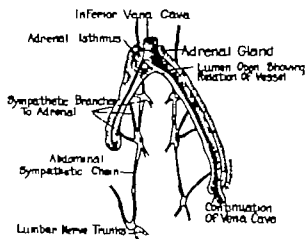


Fig. 4 The adrenal-sympathetic system of the alligator

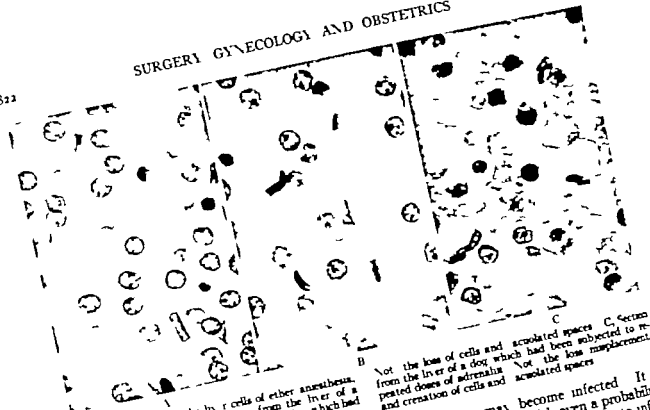


FIG. 8. Effect upon the liver cells of ether anesthesia. B and of adrenalin. C. Sections from the liver of a normal dog. B, section from the liver of a dog which had been subjected to continuous ether anesthesia for 4 hours.

Not the loss of cells and acellular spaces. C, section from the liver of a dog which had been subjected to repeated doses of adrenalin. Not the loss of cells and acellular spaces.

assumption were true the incidence of gall stones should be reduced by about 50 per cent. This is definitely not true—typhoid has disappeared, gall stones have remained. If gall stones are produced by the pyogenic infections, the greatest incidence of gall stones should occur in early life in the age of the highest incidence of infectious diseases in the period of the highest incidence of appendicitis of tonsillitis of tuberculosis, of osteomyelitis. These infections occur early in life—gall stones later.

Finally if it were a fact that infections have an affinity for the gall bladder then acute gall bladder infection should be as common as tonsillitis for the liver absorbs every kind of toxin and bacteria from the intestine. The it does not commonly become infected. The duodenum the stomach and the intestines are far more exposed to contamination than the gall bladder and ducts but they are rarely infected because they have a natural resistance. The gall bladder and ducts have a natural resistance and they too rarely have an acute infection except in the presence of stones which irritate them. If the stomach and duodenum are likewise irritated or dam-

aged they too may become infected. It is indeed difficult to establish even a probability that the genesis of gall stones is due to infection except so far as the infection may have altered the liver cells.

We may conclude therefore that gall stones are due to an often repeated or continuous interference with the quantity and quality of the secretion of the liver cells, which results in a deficiency of bile salts and fatty acids, and therefore produces an abnormal quality of bile.

We can see, therefore, why the more emotional the individual or the race the more common the gall stones how excessive fatigue or prolonged or repeated infections or pregnancy may predispose an individual to the formation of gall stones. Why the Jews and the Latins show a higher incidence of gall stones than do such races as the Hindus with the Nordics or the Chinese and the Hindus with their peculiar diet and negative philosophies of Confucianism or Brahmanism, or any human beings who have rationalized their lives and freed them from their stresses. What is there to change the liver cells in the primitive man who needs only to pluck an orange

or dig up a root, and then can sleep and loaf the rest of the day?

It is the adrenal sympathetic system acting upon the liver not the gall bladder and bile ducts which provides the fundamental cause of gall stones. It is not local infection not pathological morphology but pathological physiology which lays the background for the formation of gall stones.

We have an additional line of very definite evidence to offer. Dr Walsh has stated that in an experimental animal in which a biliary fistula has been produced in the presence of infection, the bile is not secreted in the usual amount and in normal concentration until several days after the animal has been subjected to a surgical operation and that any laboratory animal that is in ill health shows a diminution of the amount of bile secreted and in its concentration.

If there is any one fact that the experienced surgeon knows clearly regarding the sequence after operation on the gall bladder it is that a great change takes place in the quality and the quantity of the bile as the result of the surgical operation. At the present time when surgeons are commonly removing the gall bladder there is little opportunity for observing the flow of bile as in former periods when we removed the stones and drained the gall bladder. Then there was a perfect opportunity to note the effect that the anæsthetic the shock infection etc. had upon the quality and the flow of bile in other words upon the function of the liver cells. Every surgeon who remembers those days or who at the present time has observed the character of the bile in serious cases as in cases of jaundice in which the gall bladder is drained has noted that the liver cells were not able to secrete bile for a period of time perhaps not until 24, 48 or even 72 hours after the operation and he will remember his relief when normal bile again began to flow.

Every surgeon probably has performed apparently successful operations on the biliary passages of patients whose liver function was depressed. At the close of the operation the prognosis would seem promising but the following postoperative picture would soon begin to develop. The patient would become increas-

ingly apathetic his energy would be slowly depleted, though tired and weak he would not be able to sleep, the tongue would become increasingly dry, the pulse would gradually rise and its volume steadily decrease, the bile would be suppressed, nourishment would be refused, the patient's demeanor would be cheerless and despondent. The patient would seem to be sinking steadily in the quicksand of some fundamental failure of normal metabolism. No means would suffice to change the course of events. The patient would either recover gradually or else would become first delirious and then unconscious until death.

This is a familiar picture after operations on patients exhausted by chronic empyema of the gall bladder or by long continued infections from common duct stones. It is a familiar picture after operations on patients exhausted by prolonged or by sudden intense psychic strain or by some severe chronic infection. The temperature and pulse of these patients may be normal and if the prognosis were based on these factors alone the greatest errors would be made.

We now know that this picture was due to the effect of the surgical trauma the anæsthetic, and the psychic influences which attended the operation. All of these affect the adrenal sympathetic system and through the sympathetic system profoundly affect the liver cells.

It has been established by laboratory experimentation that the liver performs its function in part through direct nerve stimulation over the sympathetic system and in part through hormone action. The nerve supply of the liver is derived from the sympathetic and parasympathetic systems. These nerve fibers pass along the blood vessels and the common duct. In addition to the nerve supply to the liver as a whole each separate liver cell has its own nerve supply, not only is its outer border supplied but a filament of nerve tissue penetrates each separate cell (Fig. 6). One would expect to find that an organ every unit of whose structure is thus wired would have a close relationship with the great functions of the body.

Anyone who has operated upon the thyroid gland will remember that even an approach

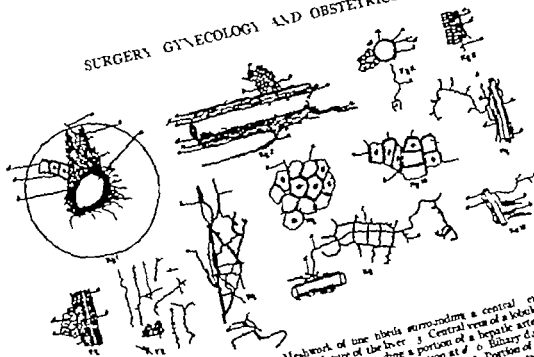


FIG. 6. Intravascular nerves of the liver. 1. Meshwork of fine fibers surrounding a central vein. 2. Drawing from a section not far from the transverse fissure of the liver. 3. Central vein of a lobule with surrounding nerve fibers. 4. Nerve and their branches surrounding a portion of a hepatic artery. 5. Portion of a biliary canal showing its C-shaped fiber with a forked termination at it. 6. Biliary duct with nerve fibers and interlobular branching. 7. Junction of nerves and terminations. 8. Portion of a coarse biliary plexus along the margin of an interlobular space. 9. Portion of an interlobular hepatic plexus. 10. Portion of the terminal distribution of a single nerve fiber. 11. Portion of a biliary plexus. 12. Neural enlargements adjacent to a portal vein in an interlobular space. From Berkeley Studies in the Histology of the Liver. The Johns Hopkins Hospital Reports, Vol. IV, p. 331.

to the recurrent nerve—merely touching it or producing the slightest traction on it—causes at once a great change in the conductivity of that nerve which is expressed by a change in the voice. The reason is that this nerve is poorly protected as are all nerves which being deep-seated have always been phylogenetically protected from injury. If it were possible for injury of the liver cells to be demonstrated by arising out as is injury of the laryngeal nerve the demonstration would be dramatic indeed.

Since as our experimental researches have shown physical trauma and inhalation anaesthesia affect the liver cells, it is obvious that for the protection of liver function minimum trauma must be inflicted and that the minimum degree necessary to secure the required relaxation, principal dependence being placed upon local, regional, and splanchnic anaesthesia.

After leaving the hospital many patients complain of a group of distressing symptoms

(1) lack of vigor and endurance (2) pains (3) indigestion. These symptoms may continue for many months—even for a year or more. It would seem that their genesis may now be explained and these sequelae prevented because as we believe the symptoms are due to injury of the sympathetic nerves which are so richly supplied in the precise area of the operative attack. These nerves are as delicate as the spinal cord. What if the neurosurgeon should pack the brain, the medulla the spinal cord to stop bleeding or retract them with force to make up for the relaxation a proper anaesthetic would give. Not only does the surgeon cause a profound interference with the innervation of the liver but also with the whole adrenal sympathetic system—with the innervation of the pancreas, the adrenal glands, the entire gastro-intestinal tract. In addition to such injury this sensitive exquisitely delicate telephone switchboard of the sympathetic system is harmed enough to cause scar tissue to form then this system will cause the above mentioned symp-

toms to continue for months or years just as in the case of injury of the recurrent nerve in a roughly conducted thyroidectomy with the formation of scar tissue

The indigestion and lassitude following operations on the gall bladder and ducts is the surgeon's disease. With this conception in mind I so plan and execute the operation that the network of the sympathetic is only slightly disturbed and as a result these distressing postoperative symptoms are no more than those which follow a pelvic operation.

From these considerations it would appear that the genesis of gall stones and the prevention of postoperative shock and of later digestive disturbances are related to the energy system which is the mechanism through which the radiant and electric energy operating the organism is principally expressed.

SUMMARY

1. A transformation in regard to our conceptions of the energy whereby living organisms are operated is now in progress and will inevitably affect biology and medicine.

2. There is nothing more definitely established than the fact that the injection of

adrenalin, the expression of an emotion, foreign proteins, an infection, a great exertion, a physical injury, pregnancy, all produce an increased activity of the energy system of the organism, and the liver is linked indissolubly with that energy system. In other words, all the factors that cause an increased output of adrenalin in the experimental laboratory have the power of changing or modifying or interfering with the cells of the liver and in consequence with their production of normal bile.

3. This change in the liver cells is the result of hyperactivity of the adrenal sympathetic system.

4. Change in the cells of the liver in turn predetermines a change in the bile content, change in the bile content, as shown by the researches cited, leads to the formation of gall stones.

5. Immediate shock and postoperative indigestion and pain are almost completely prevented by avoiding injury of the exquisitely sensitive sympathetic nerves by avoiding the formation of scar tissue which involves the rich and intricate network of the sympathetic nervous system.

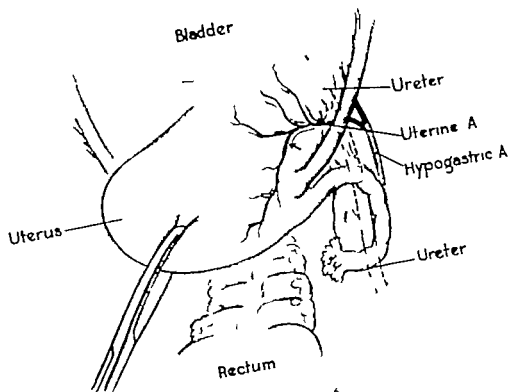


Fig 9 Step 6

Total Abdominal Hysterectomy—Lillian K. P. Farrer

CLINICAL SURGERY

FROM THE CLINIC OF THE WOMAN'S HOSPITAL NEW YORK

TOTAL ABDOMINAL HYSTERECTOMY

ANATOMY AND TECHNIQUE¹

LILIAN K P FARRAR, A B M D F.A.C.S. NEW YORK NEW YORK

THE operation of hysterectomy has been a matter of evolution over a period of approximately 50 years. Probably the greatest impetus and contribution to the technique was given by Dr Lewis A. Stimson, a founder and the first professor of surgery in Cornell University Medical College. On January 9, 1889, Dr Stimson described before the New York Surgical Society the technique of two total abdominal hysterectomies which he had just performed. In these two operations Dr Stimson had applied ligatures to the uterine arteries alone underneath the peritoneum with the object of preventing first, hemorrhage from the retraction of the blood vessels; second, the sloughing of the pedicle. In this meeting Dr Stimson asked the opinion of his fellow members of the relative value of total or subtotal hysterectomy, saying that he himself believed the total to be the better procedure. In July of that year Dr Stimson published his paper entitled "On Some Modifications in the Technique of Abdominal Surgery, Limiting the Use of the Ligature *en Masse*", and stated that if the cervix was left *in situ* it should be covered with a flap of peritoneum thus solving the problem of the treatment of the pedicle or stump which had so long been a stumbling block in hysterectomy. The value of this and the isolation before ligation of the uterine artery was quickly recognized. These two procedures have revolutionized the operation of supravaginal hysterectomy—but total hysterectomy which Dr Stimson advocated has not been at least in this country generally accepted for benign condition of the uterus.

The ease with which the supravaginal method may be carried out and the brilliant work of the leaders of the next decade have led to its great popularity in the United States—so much so that in Europe today the supravaginal hysterectomy is called the American operation. In France Doyen, Wurt and Fergue and in Germany and Austria Bumm, Doederlein and Weibel and be-

fore the latter Wertheim, have all advocated the total operation for non-malignant conditions necessitating hysterectomy. In England Mr Herbert Spencer has for years practiced total hysterectomy for benign conditions of the uterus and has published statistics for all of his cases. The wisdom of this routine practice lies in the knowledge that cancer is not infrequently associated with fibroids of the fundus and that cancer of the cervix has been reported by numerous surgeons to have developed later in the cervical stump. The incidence of cancer occurring with fibroids is probably about 5 to 8 per cent. Munro-Kerr found in his cases 5 per cent malignancy in 200 fibroid tumors of the uterus and quotes Ellice McDonald as finding 5 per cent malignancy in 700 myomata uteri. Polak studied 900 fibroids and found cancer undiagnosed and present in 2 per cent. The difficulty of curetting out all tissue from a uterine cavity distorted by myomata might be a reason for not diagnosing even a suspected case of malignancy and a second reason is that sarcoma rarely begins in the endometrium. An additional reason for the removal of the cervix together with the fundus was first given in 1896 by Chrobak, of the University Clinic of Vienna who reported 3 cases of cancer that had developed in the stump of a cervix several years after supravaginal hysterectomy had been done. In 1910 Dr John Osborn Polak collected from American literature alone 256 cases of carcinoma occurring in the cervix one year or longer after a supravaginal hysterectomy had been done and from all literature 900 cases of carcinoma occurring in the cervix thus left—Mason reported 29 cases of carcinoma in the cervix after supravaginal hysterectomy seen in 5 years at the Mayo clinic.

In the Woman's Hospital the incidence of carcinoma developing in the cervical stump one or more years after a supravaginal hysterectomy is 7 per cent of all patients who come to the clinic for treatment of carcinoma of the cervix. Spencer

¹Read before the American Gynecological Society in White Sulphur Springs, Virginia, May 1912.

quotes Peham and Amresch that carcinoma is 27 times more frequent in the cervical stump than in the cervix of women who have not had a subtotal hysterectomy. If this be so it is not probable that we are making tissue favorable to the development of cancer when we leave a cervix in doing a hysterectomy. Tissue that has been devitalized by any means such as by burning cauterization cutting off the blood supply makes that tissue more liable to become infected.

Leucorrhoea is a frequent symptom after supra vaginal hysterectomy in women who have never had a vaginal discharge before. Leucorrhoea results from the degenerative changes that follow in the mucous glands of the cervix. A chronically diseased cervix stimulates tissue reaction and cell proliferation and thus paves the way to the development of cancer. Leucorrhoea and backache are such common symptoms after the subtotal operation that many surgeons come out the cervical canal from above at the time of the amputation of the fundus or cauterize the cervical canal from below immediately preceding the abdominal part of the operation. This latter treatment however may be a source of severe infection as the slough lies so close to the abdominal wall. The coning out of the cervical tissue may or may not cure the leucorrhoea and may prevent the development of cancer depending upon how thoroughly the base of the glands are destroyed. But Peterson has shown that only one-third of the carcinoma of the

cervix begins in the cervical canal while two-thirds are of epithelial origin and begun in the portio of the cervix which is not destroyed by the coning out or cauterization of the canal. Years ago Doederlein was asked what he considered the best treatment of the cervix to be. He replied: "Die beste Stumpfbehandlung der Zervix ist eben deren ganzliche Wegnahme." This seems to be true today for as Dr. W. J. Mayo has written: "We must look upon local lesions as an invitation to cancer without regard to just what the actual cause of cancer may be. Leaving the cervix leaves an average cancer liability. And again Dr. Mayo says: 'I believe that total hysterectomy is a wise procedure if it can be done safely and usually it can.'"

The value of the total hysterectomy and the development of a simple technique was shown in 1917 by Dr. F. F. Baldwin of Columbus, Ohio. Dr. Baldwin wrote: "It entirely removes the possibility of malignant changes in the retained cervix and more or less morbidity from inflammatory or degenerative changes which may be present or which may occur in the part that is left behind. A year or two later Polak of New York published his technique demonstrating particularly the removal of the cervix. Worrell of New Zealand at this time presented his method of leaving a strip of the lateral walls of the ligaments and thus disturb the insertions of the ligaments on cutting out prevent prolapse. Lahey has much the same technique with especial guidance on this strip of uterus the cervix. Obviously though this in the fundus should not be left if cancer is present in the fundus and not infrequently cancer may be present and not diagnosed. Kennedy of the Woman's Hospital utilizes the cervical ligaments to prevent prolapse as in the vaginal hysterectomy. Richardson of Baltimore, in 1929 presented an admirably planned technique with the attention directed especially to the prevention of hemorrhage.

The higher mortality in the total hysterectomy is a deterrent to many surgeons. It may be due in part then to consider the mortality of Diamond operations. A fair statement is that of Diamond of the Hôtel Labrousse who says: "All our gynecs perform daily the subtotal, how many on the other hand have the same experience with the total?" Is it not true then that they reserve the total operation for the most seriously ill, the infected or those suspected of cancer of the fundus? *Il est donc artificiel et illogique de comparer des choses qui ne sont au fond pas comparables entre elles. Les membranes.* Certainly one cannot acquire the same skill in doing the less frequent operation as in the operation which one performs

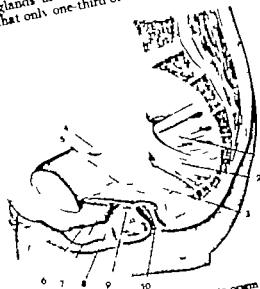


Fig. The connective tissue takes its origin from the uterus tendinous 1 M. periformis, 2 M. coccygeus, 3 M. levator ani, 4 obturator canal, 5 arcus tendineus levator ani, 6 urethra, 7 aretirovascular septum, 8 vagina, 9, recto vaginal septum, 10 rectum.

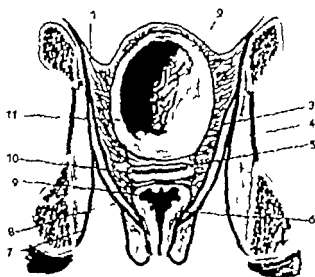


Fig. 2.

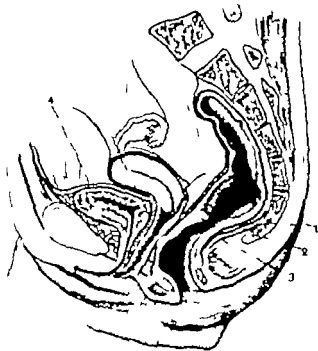


Fig. 3.

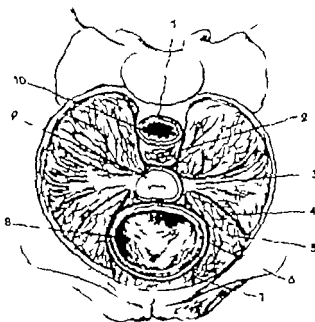


Fig. 4.

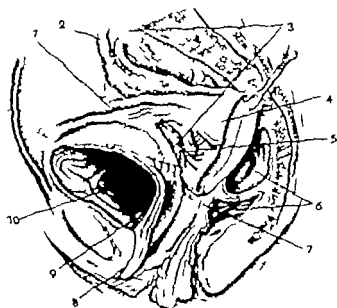


Fig. 5.

Fig. 2 The endopelvic fascia covers over the pelvic organs, separating one from another. 1 Peritoneum 2 perivesical connective tissue 3 pelvic fascia 4 obturator membrane 5 endopelvic fascia 6 perirectal connective tissue 7 obturator fascia 8 deep perineal fascia 9 rectum 10 vagina 11 bladder

Fig. 3 Septa between bladder and uterus and between uterus and rectum. 1 Perirectal connective tissue 2 pelvic fascia 3 deep perineal fascia 4 perivesical connective tissue 5 perivaginal connective tissue

Fig. 4 The endopelvic fascia radiates like an open fan from lateral wall of the uterus to the pelvis. 1 Perirectal connective tissue 2 utero-uterine ligament 3 cardinal ligament 4 ligamentum teres 5 loose connective tissue 6 perivesical connective tissue 7 pubovesical ligament 8 bladder 9 uterus, 10 rectum

Fig. 5 Dissection showing the blood supply of the uterus. 3 Uterus 4 uterine artery 5 anular artery 6 rectum 7 posterior vaginal wall 8 vagina 9 sound 10 anterior wall of vagina

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE I—FIGURES OF READ AND BELL

	Subtotal hysterectomy	Mortality per cent	Total hysterectomy	Mortality per cent
Read and Bell	129	4.5	604	3.5
Falloon and F. Allen	129	4.5	604	3.5
Robert	not given		not given	

TABLE II—NELSON'S FIGURES

	Subtotal hysterectomy	Mortality per cent	Total hysterectomy	Mortality per cent
May, Johns (1906)	1	1	29	1
Read Hospital	1	1	10	1
C. H. Ma	1	1	10	1
Kennedy	1	1	10	1

daily. Polak has estimated that the mortality of subtotal hysterectomy should be not over 1.5 per cent and the total not over 2 per cent. While many may consider these figures too low and the ratio between the two operations to be too small one must bear in mind that the mortality rate for the subtotal operation certain figures must be added to tell the whole story. When a cervical stump that has an unsuspected carcinoma is left or when carcinoma develops in it later the subsequent mortality or morbidity should be added to the primary mortality of the subtotal operation. Radium treatment for carcinoma in the cervical stump is more difficult and more liable to be followed by a vesical fistula. Radium burns of the rectum are not unusual if a supravaginal hysterectomy has been previously performed and intestinal adhesions have resulted. Treatment of amputation of an infected cervix left after the subtotal operation should also count against the incomplete operation. It may however be of interest to view the statistics of individual operations and also the statistics of individual authors. Read and Bell give the figures shown in Table I for 14 surgeons. Nelson's figures are shown in Table II.

This makes 2,712 total hysterectomies done only by individuals but by the staffs of general hospitals with a mortality less than 2 per cent.

The criticism may be made that the statistics given are for the total hysterectomy as done by specially trained groups and not by the great number of surgeons doing gynecology as part of general surgery. For as Dr. John G. Clark wrote several years ago in his article on the abdominal operation for cancer of the cervix: "The universal benefit of any medical or surgical measure cannot be great if its execution is so difficult as to render it highly hazardous except in the hands of a very few specialists. It is with the desire to help simplify the operation of total hysterectomy that I

TABLE III—INDIVIDUAL SURGEONS—TOTAL HYSTERECTOMY FOR FIBROMYOMATA

	Total hysterectomy	Mortality per cent
Lockyer	191	1
Spencer	211	1
Chas. Richardson	271	1
	not given	

report this technique. The usual objections given to total hysterectomy are (1) more difficult technique (2) danger of hemorrhage (3) danger of injuries to bladder or ureters, (4) infection from the vagina, (5) shortening of the vagina, or prolapse of the vault of the vagina. It may be well to consider these objections first.

The technique. A consideration of the anatomy of the tissues involved may help to a better understanding of the technique in the pelvis, and the complexity of terms used by different writers has led to much confusion as to the purpose of these structures. The best description today of the pelvic anatomy is, I believe, that written by Dr. Julius Tandler, professor of anatomy in the University Clinic in Vienna. Briefly summarized it is as follows: "An analysis of the endopelvic fascia (called 'endo'—within—the pelvis simply to distinguish it from the fascia that is outside, lining the walls of the pelvis) shows that:

1. It is a true muscle fascia. The connective tissue takes its origin from the arcus tendineus on each side of the pelvis (Fig. 1) and extends to the mid pelvis to be inserted into the lateral walls of the uterus, cervix, and vagina. The underlying muscle is derived from the organs to which it is attached.

2. This endopelvic fascia covers over the pelvic organs, separating one organ from another and from the serosa which lies above or around each organ (Fig. 2). It sends down septa between the bladder and uterus known as the septum vesico-bladder and between the uterus and rectum, the septum recto-vaginale. (Fig. 3.)

3. In some places this endopelvic fascia is greatly strengthened and forms true ligaments but in other places it exists merely as an areola net work the interstices of which are supplied with fat to fill in the spaces between organs. From above the endopelvic fascia appears as a broad sheet of fascia anteriorly at the base of the bladder the muscle which is derived from the vagina and bladder it extends from the os pubis to the vagina and cervix as the ligamentum pubo-vesico-vaginale. Laterally on each side of the pelvis the endopelvic fascia is composed of thick bundles of connective tissue and smooth muscle and extends

from the pelvic wall to be inserted into the lateral walls of the uterus and cervix. Looking from above the endopelvic fascia (Fig 4) radiates like an open fan from the lateral wall of the uterus to the pelvis. In sagittal section it is three-cornered. The muscle is thickest at its insertion into the uterus but varies in amount, with the age and development of the individual. In pregnancy the muscle is greatly thickened and the blood supply increased to make a vascular muscle sling for the uterus. Later in life this muscle atrophies and the fat is absorbed. The nerves, lymphatics, and blood vessels supplying the uterus, cervix and upper vagina lie in its depths. The whole forms the so called parametrium. A variety of names have been given to this structure. It is known as the ligamentum transversum colli of Markenrodt, the ligamentum cardinale of Koch, the sustentaculum of Bonney, the upper pelvic floor of Polk, etc. (The anterior and posterior lamella of the peritoneum cover the parametrium, the fallopian tube and mesosalpinx and include the ligamentum ovarii proprium and mesovarium to form the broad ligament.) At the anterior edge of the parametrium the endopelvic fascia continues on each side of the pelvis as a thick bundle of connective tissue and smooth muscle to form the so called ligamentum teres. At the posterior edge of the parametrium on each side it forms in similar way the ligamentum sacro-uterinum which unites with its fellow from the other side to surround the rectum. Between these different ligaments are spaces filled with areolar connective tissue and fat. This whole sheet of endopelvic fascia when seen from above might be likened to a cartwheel, the spokes of which are the ligaments joined at a central point the hub or uterus. When the hub or uterus is cut away the spokes or ligaments, must be united at a new central point. This joining of ligaments ensures a long vagina without danger of prolapse.

2 and 3. *Hæmorrhage Bladder and ureters* The blood supply of the body of the uterus, the cervix and the upper vagina and bladder comes from the uterine artery which is derived on each side from the hypogastric artery. After the uterine artery has crossed the ureter and before it enters the uterus it gives off three or four branches. The branch nearest to the uterus (Fig 5) is the annular artery which unites with the artery on the opposite side to supply the cervix. The second branch is the anterior vaginal artery which supplies the upper vagina and the third branch is the vesical which goes to the posterior wall of the bladder. The uterine veins follow the course of the uterine arteries. The venous return is carried

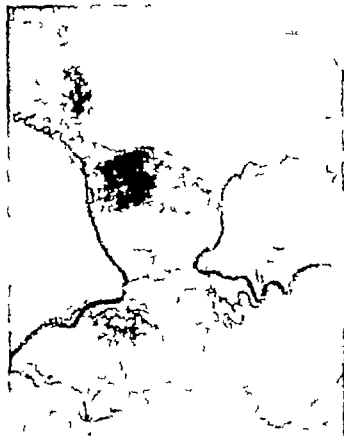


Fig 6. Blood supply of the uterus after injection of the two uterine arteries. (From Deve, Thèses d. l. Fac. de méd. Paris)

up by the uterine veins to the hypogastric veins and on the right side to the inferior vena cava on the left usually to the left renal vein. In 1892 Dr William M. Polk demonstrated before the American Gynecological Society the anatomical arrangement of these vessels and advocated ligating the uterine artery median to the anterior vaginal branch. These arteries and the plexus of veins have been clearly shown by X ray after injection (Fig 6) of the blood vessels of the uterus. Faure and Wiart in France, Bonney in England, Richardson and Lahey in this country have stressed the importance of properly applied clamps to control the arterial bleeding and the venous oozing at the vaginal angles. Bonney says: "If the arteries have been properly isolated and the clamp has been applied at a point just distal to the origin of the vaginal branch the remainder of the operation is practically bloodless. If the bladder is pushed off the anterior surface of the uterus to its interureteric fold the ureters are sufficiently far below the uterine arteries to be out of danger of

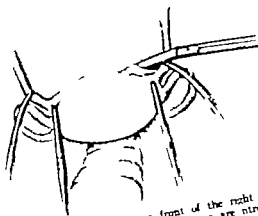


Fig. The peritoneum in front of the right round ligament is nicked and blunt-tipped scissors are introduced to push the bladder back.

injury. When the uterus is pulled upward and obliquely backward the uterine artery lies at nearly a right angle to and now well above the ureter. It is usually possible to see the course of the uterine artery after it is located at the lateral wall of the uterus and to palpate it between thumb and forefinger before it is ligated just medial to the ureter. A ligature at this point shuts off the arterial blood supply to the uterus and bladder, and a second ligature on the uterine artery as it enters the uterus shuts off a little return. If the uterine artery is not visible a little gentle palpation or teasing of the tissues as Weibel does it, or if not successful the trick as Weibel terms it will locate it. A deeper palpation with the fingers at the posterior part of the parametrium close to the uterus, as described years ago by Stimson. To quote Bonney again: "No for-

ceps are needed in cutting through the cardinal ligament when this vessel is controlled." Considerable time is saved in operating by ligating the uterine artery at these two points. There is freedom from active bleeding and also from the continued venous oozing that is so troublesome. It eliminates too the placing of clamps deep in the pelvis in close proximity to the ureters at their entrance to the bladder.

Infection. The danger of infection from the vagina in performing total hysterectomy is, I believe, far less than the danger of infection in cutting across the cervix in the subtotal operation. There are no glands in the vault of the vagina, and therefore it is easier to disinfect this area than to render sterile a cervix that may harbor infection in the depths of its racemose glands, or to render sterile a sloughing growth in the cavity of the uterus that one may have to cut into in removing the body of the uterus. Read and Bell state that the deaths following subtotal hysterectomy and pulmonary embolism is the cause of one-third of only one-tenth of the deaths in total hysterectomy. Other writers place the mortality from embolism in subtotal hysterectomy as high as 50 per cent. A low grade infection is frequently the cause of thrombosis and embolism. The higher percentage of embolism in the subtotal operation may perhaps be due to infection from a diseased cervix or infection from the intra uterine cavity.

The thorough cleansing of the vault of the vagina

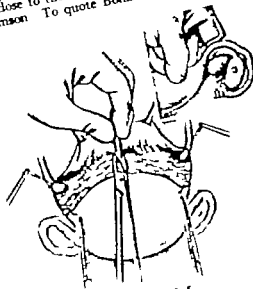


Fig. 8 Step 5

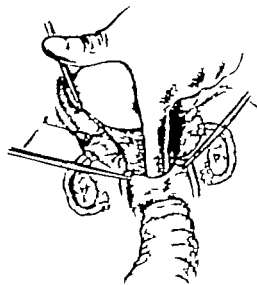


Fig. Step 6

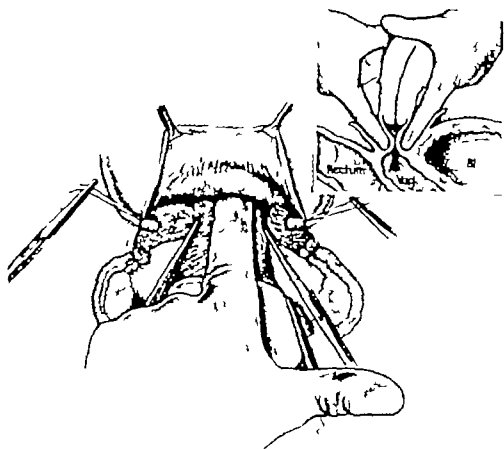


Fig. 11 Step 8.

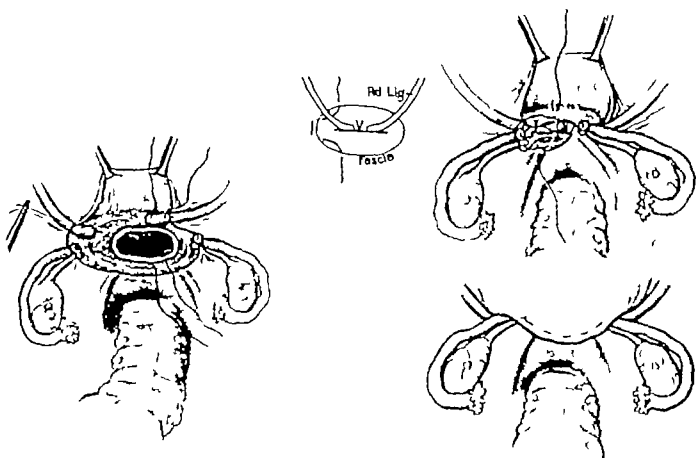


Fig. 12 Step 10

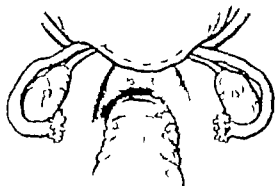


Fig. 13 Step 11

is a most important part of the preliminary preparation of the patient and should be done personally by the surgeon or at least supervised by him ally by the surgeon of vaginal tissues. The shortening or prolapse of the vagina following total hysterectomy is due to the improper suturing or not suturing of the ligaments which were inserted into the uterus. When the uterus is cut away these ligaments should be fastened to one another and to the cut edges of the vagina. This prevents either the shortening or the prolapse of the vagina.

THE OPERATION OF TOTAL ABDOMINAL HYSTERECTOMY

The investigation of a patient's condition before operation should include the usual examination of heart, lungs, and also the throat for infection, the routine urinalysis and a phenolphthalein test of the kidneys. The blood count should be not less than 3,500,000 red cells and 70 per cent hemoglobin or the operation should be postponed until a blood transfusion can be given. The white cells should be between 5,000 and 10,000. The blood pressure of normal average for the age of the patient. All cervical erosions must be healed before operation to prevent infection. The patient should be in the hospital at least 24 hours before the operation to care for the intestinal tract and prevent the farewell lunches or dinner parties that are not infrequently the cause of much postoperative trouble. A sedative the night before operation and a preliminary hypodermic of morphine and atropine helps to quiet the nerves for the operation. If the patient is elderly or a poor risk I have been in the habit of several years of having a solution of gum acacia and glucose given intravenously during the operation as a supportive measure, and at the closure of the abdominal incision to have given by rectum a quart and a half of saline solution, or what Dr. John Clark termed, an internal hot water bottle to offset the loss of body fluids.

Step 1. When the patient is under the anesthetic and in the lithotomy position after the external genitalia have been cleansed and the bladder catheterized, the entire vagina should be thoroughly scrubbed out with sterile gauze sponges on long sponge forceps. Especial care should be given to cleaning around the cervix at the vault of the vagina. A douche being used to reach to the vault of the vagina. A sterile weighted speculum double tenaculum, Denver vaginal retractor, cervical dilator, gloves, and long intra-uterine syringe will be needed. An ounce of 3%

per cent tincture of iodine is injected into the uterine cavity and the iodine withdrawn into the syringe at the external os so as to avoid any washing out of cancer cells. The cervix and vault of the vagina are painted thoroughly with fresh iodine. The external os is sutured and 3 yards of two-inch iodoform gauze is packed snugly into the vault and around the cervix. This packing helps lift the vault of the vagina when the cervix is cut out and remains *in situ* 48 hours after the operation as it keeps the tissues protected. There is no danger of sewing this gauze to the vaginal edge as there is so much elastic tissue in the vagina that it can be pulled up as soon as the cervix is cut out.

Step 2. After a median abdominal incision from the pubis to the umbilicus (or curved to right or left and then above if the abdominal wall is thick) the edges of the wound are protected with gauze. A self retaining retractor is inserted, the patient is placed in the Trendelenburg position, and the intestines are packed back (Three Bovie sell rubber pads or pockets filled with Turkish towelling are a decided help and do not sand paper the intestines as gauze packs do).

Step 3. An artery clamp is placed on each round ligament close to the uterus and the tissue pulled taut. The peritoneum just in front (Fig. 7) of the right round ligament is nicked and blunt tipped scissors are introduced to push the bladder back. The vesical peritoneum is cut after the bladder is pushed away and several Allis clamps are placed on the cut edge. The round ligaments are then cut across and each tied, the suture being left 2 or 3 inches long with a clamp on each so they are to be used in the closure of the vagina.

Step 4. A sharp toothed Kocher forceps is clamped on each side of the uterus. (No sharp toothed or elevating forceps should be applied to the fundus as cancer may be present and unsected.) A small artery forceps is passed directly under each fallopian tube and the tissues pushed downward to allow the ureters to drop farther away. The tubes and ovaries are then removed as they are deemed best, the ovarian arteries being ligated at the infundibulopelvic ligament or at the uterus. I always leave normal ovaries in the fundus, and thollogat reports no carcinoma in the fundus, and the tube with each ovary. If there is no appearance of infection in the tube, as there is less disturbance of the blood supply to an ovary if the corresponding tube is left. If the tubes are removed it is desirable to leave at least one ovary and if there is doubt as to its condition it may be placed just above the peritoneum when the abdominal wound

is closed I have done this several times and so far I have never had to remove the ovary, nor do I know of any trouble ever resulting from having left it. Each ovary and tube is ligated separately to avoid mass ligatures. If the tube is to be left I wipe out the lumen of the tube with small cotton wound applicators dipped in carbolic acid and the last one is dipped in alcohol. All blood vessels are ligated by sewing in the ligature to prevent slipping. The entire field is cleared of clamps before proceeding to the next step except the two Kochers on the uterus and the Allis clamps on the vesical peritoneum.

Step 5 The bladder is picked up with thumb and fingers and the vesical ligament is snipped with blunt tipped angle scissors, the incision being extended toward the uterus until the bladder is freed to the interureteric fold (Fig 8). When this fold is reached we know that the bladder is free to the trigone and that the ureters have dropped down in the pelvis. One can usually see the ureters entering the bladder and palpate each between the fingers as a flat cord,—and it is almost always possible except in the very fat patient, easily to trace the ureters through the parametrium.

Step 6 The uterine artery is located at its entrance into the lateral wall of the uterus. The uterus is pulled up and obliquely backward (Fig 9) and with thumb and forefinger the uterine artery is palpated for approximately three fourths of an inch from its insertion into the uterus. When certain that the blood vessels only are in the grasp of the fingers, while they are still held a needle with suture is carried directly under the vessels and tied at this spot which is *median to the ureter*, at right angles to it and now well above the ureter. I suture the uterine artery again just as it enters the uterus, and then suture the uterine artery to the fascia.

Step 7 Each uterosacral ligament is cut just above its insertion into the fascia and a Kocher clamp is placed on each ligament. The fascia is cut at this level entirely around the cervix, going approximately one fourth inch above the ligated uterine arteries. The parametrium is cut on one side to about one-half of its depth and then on the other side. The cutting is continued first on one side and then on the other until well down to the vagina. Usually when the parametrium is entirely cut through it is possible to pull the uterus up and out of the pelvis.

Step 8 To ascertain if the cervix is freed down to the vagina an incision is made between the uterosacral ligaments and the uterus is pushed forward to free it from the rectum (Fig 10). In a

similar way in front a finger is pushed down pressing back on the uterus to free it from the bladder (Fig 11). Test with a finger anteriorly and one posteriorly. If the lateral dissection has been continued downward sufficiently far the fingers will meet below the cervix.

Step 9 A bit of vaginal tissue is picked up between the uterosacral ligaments and nicked transversely. When the vagina is opened it is easy to push in a curved artery clamp fasten it on the vaginal tissue and cut the tissue close to the cervix. (I use a different clamp on the vaginal tissue from the one on the fascia simply to identify the edges of the vagina and work more quickly when suturing.) Repeat the procedure with clamp and cutting until near the bladder. Then the vaginal tissue is clamped and cut on the other side from posteriorly to the bladder. In this way the vaginal tissue near the bladder is left to the last when it will be easily seen and the bladder can be protected from injury. If one is in doubt how broad the cervix is and how far out to cut the vagina it is better to introduce a finger into the vagina rather than to put a hook into the cervix and draw it out as is often advised. When the cervix is entirely removed I apply iodine on a sponge to the vaginal edges and remove the excess iodine with a dry sponge. Up to the incision of the vagina the operative field will be almost bloodless if the ligatures have been properly applied. When the vagina is cut through there is some slight bleeding from the branches of the external vaginal arteries which supply the middle portion of the vagina and from the inferior haemorrhoidal artery but this is checked by the suturing of the vaginal edges.

Step 10 The edges of the cut vagina are closed with No. 2 plain catgut suture beginning on the right posteriorly, passing the suture from without into the vagina and out at the extreme right end of the tissues and returning into the vagina and then out at the anterior edge of the vagina (Fig 12). This secures the right side and I include at the same time a bite of the right round ligament and tie. A suture then from the posterior cut edge of the vagina to the anterior edge of the vagina closes the right half of the vaginal opening. In this suture I include again the round ligament, near its cut end. This firmly secures the vaginal tissues against prolapse. The steps are repeated on the left half of the vaginal opening.

Step 11 With the same type of suture the fascial edges are united, beginning posteriorly on the right by passing the suture from without through the fascial opening and out the extreme right end of the fascial tissue and back in this same tissue

and then out through the anterior edge of the fascia exactly as in the closure of the vagina (Fig. 13). Next a suture is passed from without through the right uterosacral ligament (included in this suture is the cut ends of tube and ovary if they have been left) and through the anterior edge of the fascia and tie. This procedure is repeated of the fascia and tie now only the peritoneal left side of the raw surfaces. There remains now only the raw surfaces. The

Step 12 There remains now only the peritoneum to be closed over the raw surfaces. This should be done carefully so that no raw edge is left for an adhesion to the intestine and possible debris later. A Lambert suture introduced one-eighth inch from the cut edge of the vesical peritoneum will roll in this edge and leave a smooth surface when the peritoneum is sutured down to the raw tissues.

Closure of the abdomen is the final step in the repair of the pelvic floor and is to be included in the hysterectomy if the patient is to warrant it.

This is the third year I have used this technique and so far there has been no haemorrhage, no injury to bladder or ureters, and no prolapse of tissues. It requires only a few minutes longer to perform than the subtotal operation but is well worth the time. The postoperative convalescence is decidedly better than after the subtotal hysterectomy. The mortality up to now has been 1.8 per cent.

SUMMARY

JOHN A. SIMMONS, a founder of an American school of gynaecology in Cornell University, has written a book in favour of the following

SUMMARY

SUMMARY

- (1) To Dr. Lewis A. Stimson, a founder of and the first professor of surgery in Cornell University Medical College belongs the credit for the following technique: (a) The locating of the uterine artery as it enters the uterus, and isolating of it before ligating when performing hysterectomy;
- (b) The covering of the pedicle or stump left in subtotal hysterectomy with a flap of peritoneum;
- (c) The recommendation of total hysterectomy which he performed in 1886;
- (d) The performance for total abdominal hysterectomy by the technique of the anatomy of the endometrium and the anatomy of the uterus.

3 This technique for total abdominal hysterectomy is based upon the anatomy of the endopelvic fascia and blood supply of the uterus, cervix, and vagina.

3 It lessens the danger of haemorrhage, pelvic fascia and vagina cervix, and to infection from junction to bladder or ureters, and to the uterine cavity passing across the cervix or into the vagina or pro-

3. It lessens the tendency of the uterus to bladder or into the rectum by cutting across the cervix or into the uterus.
4. It prevents shortening of the vagina.
5. It prevents the possibility of the use of the vaginal tissues after the operation.
6. It prevents the possibility of the use of the abdominal hysterectomy avoids the possibility of a diseased cervix or an unsound uterus.

5 Total abdominal hysterectomy
of leaving a diseased cervix or
in the cervix subtotal hysterectomy
blood sup-

5. Total abdominal hysterectomy with removal of ovaries and uterus, with the danger of leaving a diseased cervix.

ply and like all devitalized tissue is liable to infection. Many patients who did not have a discharge before the operation suffer later from an annoying leucorrhoea.

7 A devitalized cancer of the cervix. Many cases have a patient as cancer of the cervix. Many cases have a chronically diseased cervix. Many cases have a subtotal hysterectomy.

8. It is illogical to compare the mortality of the subtotal with the total hysterectomy as the conditions for which the two operations are performed are very different. Most surgeons perform distal supravaginal hysterectomy for fibromyoma of the uterus and do a total hysterectomy infrequently and usually only when it is known that the fundus is present.

9. For a fair comparison of the subtotal and total hysterectomies one must add to the primary mortality of the subtotal operation the subsequent morbidity or mortality of the removal of a diseased cervix, or radium treatment for a cervix that has developed cancer following hysterectomy. Total abdominal hysterectomy has been shown by many surgeons with a mortality rate of 1.5% to be a subtotal hysterectomy and not a total one. The design of the design

10 Total abdominal hysterectomy is performed by many surgeons with a low or lower than the subtotal hysterectomy should be the operation of choice for benign conditions of the uterus necessitating hysterectomy.

BIBLIOGRAPHY

- [illegible]

10. BOURDE, Y. Un danger de la rachianesthésie dans l'hystérectomie totale. *Gaz. d'hôp* 1928, 101 56
11. BUCK, Zschr. f. Geburtsh. u. Gynec. 60 189
12. CHATON, M. Deux détails techniques à propos de l'hystérectomie. *Bull. et mém. Soc. nat. de chir.* 1928, 54 631-633
13. CHROPAK, R. *Monatschr. f. Geburtsh. u. Gynec.* 1866 177
14. CLARE and NORRIS. Ovarian conservation in hysteromyomectomy. *Surg. Gynec. & Obst.* 1922 34 500
15. CORNIL, L. and FOLLIE, J. Les formations ovariennes para-utérines consécutives à la castration totale. *Presse méd.* 1931 39 1445-1448.
16. COTTE, G. and PONTIUS, R. L'hystérectomie abdominale subtotale totale. *Gynec. et obst.* 1929, 19 354-359.
17. CROSSEN, H. S., and CROSSEN, R. J. *Operative Gynecology* 4th ed., pp 389-396 445 St. Louis The C. V. Mosby Co. 1930
18. CURTIS, ARTHUR H. The pathology and treatment of chronic leucorrhoea. *Surg. Gynec. & Obst.* 1923 37 657
19. DENIKER, M. Totale ou subtotale? *Médecine*, 1933 14 265-266.
20. DIAMANT-BERGER, L. Contribution à l'étude de l'hystérectomie abdominale totale. Thèse de doct. Par 1929
21. DOERFLER, M. *Monatschr. f. Geburtsh. u. Gynec.* vol. 61.
22. DURANT, G. and ROULLAND, H. Placentome malin et lésions utérines pré-existantes, perforation utérine spontanée, hystérectomie totale, greffe vaginale immédiate, mort. *Gynécologie*, 1926 25 515-520
23. TAURE, J. L. Hystérectomie totale ou subtotale? Leçons du jeudi soir à la Clinique Tarnier 1930, 7 210-217
24. Idem. Hystérectomie abdominale totale ou subtotale? *Presse méd.* 1933, 41 65-66
25. FISCHER, L. C. Complete extirpation of uterus with illustrations of dissection and anatomical relations. *Bull. Davis-Fischer Sanator* 1928, 1 13-37
26. FORCUL, E. Hystérectomie abdominale totale ou subtotale. *Presse m. d.* 1932 40 1461-1465
27. DE FOURMESTRAUX, J. L'hystérectomie large dans le cancer de l'utérus résultats techniques. *Bull. et mém. Soc. nat. de chir.* 1925, 51 831-837
28. FRANK, K. The technique of abdominal hysterectomy for carcinoma of the uterus. *Surg. Gynec. & Obst.* 1926 43 185-190
29. FULLERTON, W. D. and FAULKNER, R. L. Hysterectomy clinical investigation of 1851 consecutive operations. *J. Am. M. Ass.* 1930, 95 1563-1567
Tr. Sect. Obst. etc. A. M. A. 1930, pp 318-333
30. GARDNER, G. H. Nelson's Loose-leaf Surg. Adenocarcinoma of the body of the uterus 1932 7 209
Pan-hysterectomy 7 229-232
31. GOSSET, A. and MILLANTON, N. Hystérectomie abdominale totale pour fibrome. *Ann. de méd. et de chir.* 1927-28, 1 1-9
32. VON GRAY, E. Abdominal total hysterectomy. *Am. J. Obst. & Gynec.* 1932, 23 195-199
33. GRAVER, W. P. *Obstetrics and Gynecology* By Arthur H. Curtis. Uterine Myomata. 1933 2 744 Hysterectomy 2 788, 818-821
34. GRIMAUD, L. Deux cas de cancer de l'utérus. Hystérectomie élargie. Mikulicz Guérison. *Bull. et mém. Soc. nat. de chir.* 1928, 54 1366-1368
35. HALBAN, J. Uterusextirpation oder supravaginale Amputation bei Myomen? *Zentralbl. f. Gynaek.* 1924 48 2674-2678
36. HARTMANN, H. FABRE, S. and DUBOT-ROQUEBERT. Traitement des cancers développés sur des cicatrices vaginales après hystérectomie totale. *Cynéc. et obst.* 1920 20 1-8.
37. HEALY, W. P. *Obstetrics and Gynecology* By Arthur H. Curtis. Carcinoma of the body of the uterus 1933 2 922 Total hysterectomy 2 935
38. HENROTAY, J. L. Sur la douglasseite. *Bruxelles-méd.* 1928, 8 1007-1009
39. HODURON, R. Die vaginale Totalextirpation des graviden Uterus in Lokalanästhesie bei aktiver progredienter Lungentuberkulose. *Ztschr. f. Geburtsh. u. Gynaek.* 1929, 96 35-40 *Zentralbl. f. Gynaek.* 1925 49 1250-1254
40. JUNG, P. Zur Bewertung der "Ausfallsrechnung" nach subtotaler und totaler Entfernung des Uterus unter Erhaltung der Ovarien. *Schweiz. med. Wchnschr.* 1928 58 1129-1132 *Rev. méd. de la Suisse Rom.* 1928 48 336-345
41. KELLER, R. Les complications post-opératoires après l'hystérectomie élargie pour cancer du col utérin. *Gynec. et obst.* 1929 20 28-37
42. KENNEDY, W. T. Reconstruction of cervical ligaments following complete hysterectomy. *Am. J. Obst. & Gynec.* 1930, 20 51-56
43. KERMAUNER, F. Biologie und Pathologie des Weibes. By Halban and Selta. Klinik und operative Behandlung der Krebsformen der Gebärmutter 1928, 4 760-904
44. KOTTMAYER, H. W. In hysterectomy for benign disease should the cervix always be removed? *South M. J.* 1929, 22 475-478
45. KRIVICKY, L. A. Supravaginale Amputation oder abdominale Totalextirpation des Uterus bei Fibromyom? *Zentralbl. f. Gynaek.* 1927 51 2190-2197
46. LAUREY, R. De l'hystérectomie élargie dans le cancer du col utérin (technique de Villard). *Lyon chir.* 1930, 27 445-462
47. LAUREY, F. H. Removal of the cervix in hysterectomy for benign lesions. *Surg. Clin. N. America*, 1926 6 595-595
48. Idem. Simple method of removing cervix with uterus in hysterectomy. *Surg. Gynec. & Obst.* 1928, 46 257-260.
49. LARGYONNE and MARION, J. A propos d'un leuomyome malin survenu sur la cicatrice vaginale d'une hystérectomie totale pour fibrome. *Lyon méd.*, 1929, 144 617-622
50. LARRIBÈRE. Infection amniotique hystérectomie en bloc. *Bull. Soc. d'obst. et de gynec.* 1933 22 348
51. LAURENTE, L. De l'évidement large du col, temps complémentaire de l'hystérectomie subtotale. *Rev. franç. de gynec. et d'obst.* 1924, 19 401-404
52. LEDOUX, A. J. E. Contribution à l'étude de l'hystérectomie abdominale totale, avec drainage (Indications principales, technique opératoire, drainage associé). Thèses de doct., Par 1925
53. LOCKYER, CUTHBERT. *Brit. M. J.* 1924, 1 1038
54. MAMAZZA, M. Esiti della allacciatura dell'arteria ipogastrica nella isterectomia totale estesa. *Folia gynaec.* 1932 20 301-312
55. MARSON, J. C. Total versus subtotal abdominal hysterectomy. *Am. J. Obst.* 1927 14. 486-492
Tr. Am. Gynec. Soc. (1927) 1928.
56. MATO, C. H. Cancer of the cervical stump following subtotal hysterectomy. *Ann. Surg.* 1931 vol 93

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- 57 MAYO W J The prophylaxis of cancer Tr Am Surg Ass 1914, vol 33
- 58 Idem Collected Papers of the Mayo Clinic, 1920, 13 377
- 59 MONTAGNINO J L Elevation de l'utérus par voie vaginale dans l'hystérectomie abdominale totale Gynec et Obst 1930, 31 366-369
- 60 MORAWA R L'hystérectomie totale pour carcinome de l'utérus d'après le procédé de Kelly-Segond-Bontheur Thèse de doct. Geneva, 1928
- 61 NIZANOW H M Comparative study of complete and subtotal hysterectomy J Michigan M Soc 1930, 28 850-863
- 62 OKABAYASHI H Abdominale systematische Panhystérectomie fuer Karzinom des Uterus Jap J Obst & Gynec 1928, 11 136-153
- 63 OKUBICHT J Hystérectomie totale ou subtotale a propos de 388 observations personnelles Gynec et Obst 1933 27 115-121
- 64 OKU M Pithuitin as a remedy for postoperative paralysis of the urinary bladder Jap J Obst & Gynec 1930, 3 437-439
- 65 v OTT D Die supravaginale Amputation des myomatösen Uterus oder desmen Totaleruptation? Monatsschr f Geburtsh u Gynaek 1928, 78 108-113
- 66 PATHEK R L Genital prolapse following total hysterectomy successful operative procedure Arch Surg 1930, 30 537-643
- 67 PINKAS H Ueber die Erfolge der erweiterten Operationen bei Karzinom des Uterus Wien Klin Wochenschr 1929, 43 1621-1624
- 68 PRITZ W ANDERICH Gynaekologische Operations Lehrb 1930, 410
- 69 PRINCEUT L E Two new clamps for abdominal panhysterectomy New England J Med 1930, 103 1131 1 33
- 70 POLAK J O Total hysterectomy J Am M Ass 1930, 75 370
- 71 Idem Incidence of carcinoma of the cervical stump New York State M J 1931 21 45
- 72 POUL WILLIAM M Abdominal hysterectomy Tr Surg 1924, 37 591-593
- 73 POUL WILLIAM F B Ligature préventive des deux artères hypogastriques dans l'hystérectomie abdominale totale Thèse de doct. Bordeaux, 1925
- 74 REID C D and BRILL A C Hysterectomy, sub-total and total—review of mortality and morbidity in series of 2444 consecutive cases at Chelsea Hospital for Women in 10 year period, 1921-1933 Obst & Gynec Brit Emp 1933, 40 149-157
- 75 REID G C Complete hysterectomy Internat J Surg 1924, 37 591-593
- 76 RICHARDSON E H Simplified technique for abdominal panhysterectomy Surg Gynec & Obst 1930, 48 245-256 J Am M Ass 1928, 83 48-51
- 77 Idem Abdominal panhysterectomy simplified, in-creased results Tr South Surg 1930, 48 245-256
- 78 Idem Abdominal panhysterectomy technique Am (1930) 930, 43 83-90
- 79 Idem Am M Ass 1928, 83 48-51
- 80 ROTT H L'opération pour cancers utérins très étendus et compliqués Rev franç de gynéc et Obst 1931 26 436-440
- 81 SAKURAI and LEVITZKYA De l'utérus et l'hystérectomie radicale au cours du cancer de l'utérus avec l'extirpation de la cage et transportation des uretères dans le gros intestin Cancer (Bruxelles) 1932 9 245-261
- 82 SOLOVOWE, BETHUEL The technique of total hysterectomy Surg Gynec & Obst 1930, 31 401-403
- 83 SPECKER H R Remarks on total abdominal hysterectomy for myoma of uterus, with special reference to cancer of cervix after subtotal operation Brit M J 1932, 1 1157-1160
- 84 STARRO P Formazioni cistiche a sede pelvica in donne procedente sottoposte ad istero-annektomie bilaterale Rassegna internat di gynec et obst 1933, 14 517-525
- 85 STERNOW LAUREN A Abdominal Surgery Med New York M J 1930, 11 1157-1160
- 86 SUTHERLAND P Zur Verringerung der Mortalität nach der Wertheimischen Karzinomoperation Zentralbl f Gynaek 1931, 56 461-464
- 87 TAGLIAPIETRA P Sul destino della donna operata per carcinoma totale o supravaginale con coelomectomia totale o supravaginale con coelomectomia delle ovaie Ann di obst. e gynec, 1932, 54 77-104
- 88 TAYLOR J Hystérectomie abdominale totale par 1929, 21 127-124
- 89 TAYLOR L De l'hystérectomie abdominale totale systematique dans le traitement du cancer de l'utérus (technique) Libres hebdomadaires de l'ecole de médecine 1931 30 630-654
- 90 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 91 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 92 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 93 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 94 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 95 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 96 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 97 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 98 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 99 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 100 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 101 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 102 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317
- 103 TAYLOR L and PORTLAND Hystérectomie abdominale recto-vaginale. Lyon chir 1930, 27 305-317

104. Idem. Hunterian Lecture. Surgical treatment of cancer of the cervix. *Lancet*, 1930, Feb. 8, 277
 105. CLARK, JOHN G. Radical abdominal operation for cancer of the uterus. *Surg. Gynec. & Obst.* 1913 16 255.
 106. CLAUSER, F. Contributo clinico ed anatomo-patologico allo studio dei risultati tardivi dell'operazione Wertheim Schauta. *Folia gynaec.* 1925-1926, 21 65-99
 107. DOUAT and ANTONIOPOULOS. Complications urinaires après l'opération de Wertheim. *Gynec. et obst.* 1931 23 196-207
 108. GOULLEROUX. A propos de l'opération de Wertheim. *Lyon chir.* 1931 28 347-348
 109. SAKSBOOM. Radical abdominal operation for cancer of the cervix. *Surg. Gynec. & Obst.* 1913 16 304
 110. THIE-GABRIELIAN G. G. Vergleichende Bewertung der Operation nach Wertheim und nach Schauta bei Gebärmutterkrebs. *Zschr. f. Krebsforsch.* 1928, 26 450-460.
 111. WAGNER, G. A. Die abdominale Radikaloperation des Carcinom colli uteri nach Wertheim. *Chirurg.* 1928, 1 40-50
 112. WEISKE, W. 25 Jahre "Wertheimacher" Carcinom operation. *Arch. f. Gynaek.* 1928 135 1-57
 113. WERNER, P. Zur Verringerung der Mortalität nach der Wertheim'schen Karzinomoperation. *Zentralbl. f. Gynaek.*, 1931 55 2871-2873
 114. WERTHEIM. Die erweiterte Abdominale Operation bei Carcinoma Colli Uteri, Leipzig, 1911
 115. WOLLNER, A. Relative value of Wertheim and Schauta operation in cancer of cervix. *Am. J. Surg.* 1928, 5 468-471
- Anatomy of the Broad Ligament*
116. BEEBELEY and BOWEN. *Gynecological Surgery* 2d ed. 1920
 117. BOWEN VICTOR. The sustentacular apparatus of the female genital canal. *J. Obst. & Gynaec. Brit. Emp.* 1914, 125 329
 118. BEHREBERG and HEYMAN. Ueber den Ursprung—des glatten muskulatur in dem Ligamenta lata. *Arch. f. Anat. u. Physiol.* 1898.
 119. CAMERON. Fascia of the perineum and pelvis of the female. *J. Anat. & Physiol.* 1908 vol. 42
 120. FOTHERGILL. The supports of the uterus. *Brit. M. J.* 1913 7 no. 17-45
 121. HALBAN and SERIZ. Biologie und Pathologie des Weibes 1927 4 478.
 122. HALBAN and TANDLER. Anatomie und Etiologie, der genital Prolapse beim Weibe 1907
 123. HALL. Die Muskeln und Fasern des Beckenausganges. *Handbuch der Anatomie. By Bardeleben* vol. 7 no. 4
 124. KOSTANECKI. L'evolution du Segment latéral du Ligament large. *Arch. d'anat. d'histol. et d'embryologie*, 1930-1931 12 75-108
 125. LIEPMANN W. Das gynäkologische Seminar. *Arch. d'anat. d'histol. et d'embryologie* 1931
 126. MACKENRODT. *Zentralbl. f. Gynaek.* 1894, No 8, 180
 127. MARTIN EDOUARD. Der Haftapparat der weiblichen Genitalien. Part 1
 128. MORITZ. On the nature of the so-called ligaments of Mackenrodt. *J. Obst. & Gynaec. Brit. Emp.* 1913 23 125 1914, 26 178
 129. NYULASY. The supports of the uterus. *Surg. Gynec. & Obst.*, 1921, 33 53
 130. OKSZEI. Biologie und Pathologie des Weibes 1924 Anatomie Histologie und Topographie des weiblichen Urogenital Apparats
 131. PARAMORE. The statics of the female pelvic viscera, 1918.
 132. TANDLER, JULIUS. *Handbuch der Gynaekologie* By Velt-Stoerck. Anatomie und topographische Anatomie der weiblichen Genitalien, 1930 p. 297
 133. Idem. *Lehrbuch der systematischen Anatomie* Vol. 2 1923 pp. 296-312
 134. TANDLER and HALBAN. *Topographie des Weiblichen Ureters*. Wien and Leipzig, 1901
 135. TEXTUR. *Traité d'Anat. Humaine*, 8th ed. 5 358

THE SURGERY OF GANGRENE OF THE EXTREMITIES

WITH A STUDY OF 171 CASES FROM THE RECORDS OF THE NEW ORLEANS CHARITY HOSPITAL¹
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MERLE Scott, Mont Reid and one or two other writers have repeatedly made the point that the field of arterial vascular disease has long been a neglected field and a badly handled field and Reid in a recent brilliant survey of the whole subject goes even further. Students and surgeons, he says, are no longer satisfied with efforts to classify gangrene and to determine the optimum level of circulation to stand they want to know the actual degree of circulatory embarrassment and to evaluate the rôles of the vasomotor nerves, mechanical obstruction, infection and the general condition of the patient. His attitude is both wise and hopeful for gangrene which is really an end-result as the initial manifestation of arterial obstruction and its management is still characterized by an attitude of utter hopelessness that does not promise well for the results of treatment. That there is some justification for despair it must be admitted. The patient with arterial obstruction must be saved from his disease before gangrene sets in if he is to be saved from death or from mutilation and that implies an entirely new conception of the condition on the part of the profession as well as of the laity. Reid and his associates at this time are voices crying in the wilderness, but they are also heralds of a new day.

On the other hand, however much one applauds their efforts and endeavors to emulate their methods the fact remains that the treatment of vascular disease of the extremities among intelligent private patients and its treatment, or rather the treatment of its terminal phenomenon gangrene, among ignorant public charges, are two very different matters. J. M. T. Furney, Sr. was quite correct when he remarked that anybody could amputate a leg but that it took a good surgeon to save a man. He did not however go all the way even the best of surgeons cannot save a leg that is beyond saving when it is first seen or that can be saved only by an unjustifiable risk of the time the public hospital the surgeon most of the has just one course open to him, prompt amputation for the reason that the patient most of the time presents himself too late to make conservation safe or practical. If he resorts to amputation without delay he may—though he does not

always—save the patient's life. If he practices watchful waiting hoping to avoid the mutilation that is abhorrent to all his instincts and training, he frequently falls in his attempt at salvage, and he always introduces the risk of an increased morbidity and mortality. The surgeon who procrastinates, no matter how worthy his motives may be, adds to the death rate in gangrene just as inevitably as does the patient who delays presenting himself for treatment or who refuses surgery when it is offered to him.

But there is another problem besides the major one of whether or not to amputate. Where to amputate is a very serious consideration. Some surgeons notably Eliason still observe the Heidenhain law that amputation is, as a rule best done high because at that level the presence of an adequate circulation is ensured. That there is ample ground for this position cannot be denied, at least in the absence of reliable tests to determine the constant observance of this rule is open to objection on two points. The first, and more immediately important, is that in all amputations the mortality rises in direct proportion to the nearness of amputation to the trunk, although the risk of secondary gangrene is naturally very much less. The second is that it is seldom possible to fit an artificial limb satisfactorily above the knee, because although a pressure-bearing stump can be obtained with little difficulty leverage to manipulate the leg is lacking. That point we do not believe as does Eliason can be ignored, particularly in these days, when more than ever before economic usefulness must be taken into consideration.

During the 5 year period ending in December 1933 there were 171 amputations of the extremities for primary vascular disease at the New Orleans Charity Hospital, of which 110 were for arteriosclerotic gangrene. 45 were for diabetic gangrene. 14 were for Buerger's disease and 1, both in cardinals were for embolic gangrene involving the popliteal artery. Sixty-seven of these patients died a mortality of 39.1 per cent, which though it is about the mortality reported from other clinics handling the same type of case is sufficiently high to demand earnest consideration, especially since preventive measures can elim-

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nate much of it and can materially reduce the mutilating surgery which gives rise to it. We should be derelict, too even though we have attempted no follow up on these patients, if we did not emphasize a fact which Eliason called attention to in his most recent publication on this subject, that the immediate surgical and the deferred hospital death rates do not tell the whole story, to them must be added the proportion, the appalling proportion of patients who die within the year after their discharge and who cannot be ignored when the accounts are finally cast up.

The pathology of the various types of gangrene is so clearly understood today that only one or two practical considerations need be stressed here, the first of which is that whether the individual is suffering from arteriosclerosis *per se* or from arteriosclerosis associated with diabetes the fundamental pathology is precisely the same, its manifestations being different merely because in diabetes an additional metabolic factor is introduced. The essential sameness of these two types of gangrene was first pointed out by Buerger and by Eliason and Wright, and the correctness of their contention was immediately recognized. In both diseases the underlying pathological change is an obliterating endarteritis frequently associated with calcium deposits which affects all the vessels of the body from the thoracic aorta to the finest radicals. The narrowing of the lumen in the large vessels amounts, in the smaller vessels, to practical occlusion and leads in turn to alterations in the nutrition of the tissues especially of the kidneys, the brain the myocardium and the extremities, of which gangrene may be the end result.

The fact that the diabetic exhibits his sclerosis at an earlier age by approximately 10 years than does the essential arteriosclerotic, a difference which was first emphasized by Eliason and Wright, we shall discuss in more detail later. Here we would merely point out that the metabolic perversion of the diabetic counterbalances, if we may so express it, the enfeebled heart and kidneys of the older arteriosclerotic and that their surgical risk is from this standpoint, about the same. But the diabetic is peculiarly prone to infection, and when infection is once introduced insulin which is his sheet anchor at other times, loses a large part of its effectiveness and his risk is many times increased. The reaction of the arteriosclerotic to infection is more sluggish but it is by no means absent. It is present more often than is generally realized but it is a deep seated infection an underground process if we may so express it, that spreads along tissue planes and

that only rarely manifests itself by the line of demarcation for which traditionally the surgeon waits and because of the delay in the formation of which so many lives have been sacrificed. In both arteriosclerotic and diabetic gangrene, infection is always actually or potentially present. The arteriosclerotic may react to it more sluggishly, his gangrene may begin as the dry type, in contradistinction to the moist and always potentially infected gangrene of the diabetic, but in both diseases a vicious circle is likely to be established in which infection increases gangrene and gangrene increases infection.

The constitutional reaction in the diabetic is case for case, more marked than in the arteriosclerotic. The temperature rises the pulse is accelerated, and the increase in the blood sugar, the development of glycosuria, and the tendency to acidosis which result from the local condition are exceedingly difficult to control by routine or even extraordinary measures. In the arteriosclerotic the rise in temperature and in pulse rate is rarely marked in the early stages and is at any time a poor index of the amount of infection and toxemia present, as the surgeon who so regards it frequently finds to his cost. The added decade of life with all that it implies in the way of decreased function of the vital organs introduces an immediate added risk, and a clinical appreciation of the patient's general well being or more correctly, his lack of well being is a better guide to his condition than are the usual signs. In these patients toxemia is manifested by an indifference to food a markedly reduced fluid intake with a corresponding reduction in the fluid output, a listlessness and drowsiness that at times approach actual stupor and an involvement of the cerebral vessels manifested in many cases by a mild senile dementia. This picture we have been particularly impressed with in the patients in our colored male wards and the improvement in our results since we have realized its significance and have sought to correct it, especially by forced fluids before and after operation has been most gratifying.

Buerger's disease or thromboangitis obliterans which is a presenile inflammatory disease of the vascular system characterized by gangrene of the fingers and toes rather than by massive gangrene exhibits as a rule premonitory signs and symptoms which cause the patient such extreme discomfort that he usually presents himself for treatment long before frank gangrene impends. The possibility of gangrene in the diabetic is always present in the mind of a careful physician, provided that the diabetic has presented himself

for treatment which is not always the situation. Eliason reports that more than half the patients with diabetic gangrene in his series did not know they had diabetes and we found almost the same proportion in our own cases. The danger to the diabetic of minor trauma such as arises from perching calluses, cutting corns, wearing tight shoes or shoes with rough linings, or even stubbing the toe, has been repeatedly emphasized but we do not believe that the almost equal danger of such slight insults to the arteriosclerotic has been sufficiently stressed. Moreover it has only recently been realized that patients with arteriosclerosis frequently exhibit signs of their disease which if properly interpreted, can serve to prevent graver consequences. Reid more than any other writer has stressed the fact that intermittent claudication pain in the feet and legs which is aggravated by walking and is worse at night, numbness and coldness of the extremities, swelling, discoloration and similar signs and symptoms all demand prompt attention and treatment because they are all warnings of impending trouble.

We were particularly interested in this phase of the cases we studied. In 139 of the 171 cases it was possible to determine from the history the precipitating cause of the gangrene which proved to be trauma in 43 (of 91) cases of arteriosclerotic gangrene 28 (of 41) cases of diabetic gangrene and 2 (of 7) cases of Buerger's disease. That is, trauma of some sort precipitated the gangrene in 73 of 139 cases in which the history was adequate. Furthermore in more than half of the cases in the arteriosclerotic group the history showed that arterial disease had been present and could have been treated long before the gangrene made its appearance, for the signs and symptoms had not been noted again and again. Patients can not be treated of course who do not present themselves for treatment but at that, one looks with regret on the lost opportunities in this particular group of cases, on the fatalities that could have been averted, and on the radical surgery that had to be done because those opportunities were lost.

Lemann writing in 1927 on gangrene in the South, called attention to poor pedal hygiene as a very important cause, particularly among negroes, and we desire to stress that point again. Indeed we could scarcely avoid stressing it, for 107 of these 171 cases, 62.5 per cent occurred in negroes, as did 42 of the 67 deaths, 62.6 per cent. All the points that Lemann made 7 years ago still hold. Negroes wear cheap and badly made shoes, which are full of unevenness if not of actual holes, their socks if they wear socks,

are in like condition their feet are badly kept and seldom washed, and partly because of the color of their skin, partly because of their habitual uncleanliness, minor abrasions and injuries, even initial gangrene, are frequently overlooked. The negro's habit of smearing himself with salve for all local conditions is often at least a partial explanation of the infection which usually accompanies his gangrene while his habit of delay in treatment for even serious disease is too well known to need extended comment. It does seem obvious, however from what we have just said, that it is quite as important to advise the arteriosclerotic in the care of his feet as it is to advise the diabetic.

The difference between the white and negro incidence and mortality is so striking as we have just noted that it is unfortunate that no comparative figures are available. In our own series 80 cases of Buerger's disease as would be expected occurred in the negro, but 82 of the 110 cases of arteriosclerotic gangrene were in the race as were 25 of the 45 cases of diabetic gangrene. In Eliason's last report of 175 cases of diabetic gangrene the negro to white ratio was 1-4 but a comparison with our own statistics means nothing in view of the different racial proportions in the two cities, not to mention the fact that the negro of the South and the negro of the North are in all respects different. Lemann, writing in 1927 pointed out that in the preceding 6 year period 1 of every 5 negro diabetics applying for admission to the New Orleans Charity Hospital exhibited gangrene, the negro incidence of that complication being 21 per cent against the white incidence of 14 per cent. In our own figures, which cover the period from 1929 through 1933 we found the disproportion still existing though it was less striking. Forty of the 310 cases of diabetes in the negro were associated with gangrene 13 per cent, against 44 of the 582 cases of diabetes in the white, 7.56 per cent, the reduction undoubtedly being due to the wider and more intelligent use of insulin in these later years. The mildness of our climate too, may play some part for our general incidence for both races of 9.4 per cent is decidedly less than the 13 per cent which Eliason reports in his cases.

The incidence of syphilitic disease in the South is generally admitted, and syphilitic patients, it is generally admitted, are prone to develop arterial disease earlier than their uninfected brothers. Joëlin many years ago made the point that diabetic patients with gangrene show a positive Wassermann seven times as frequently as do diabetic patients without gangrene in his whole

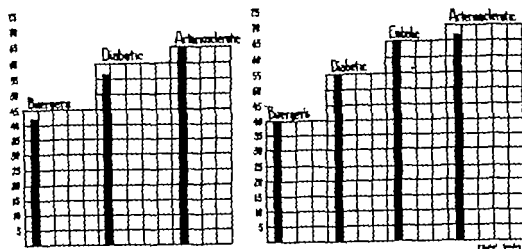


Fig. 1. Left, average age of onset in various types of gangrene. Right, average age of death in various types of gangrene.

series only 2.8 per cent of all diabetics exhibited gangrene against 10 per cent of syphilitic diabetics, but these figures Lemann was unable to corroborate for the South. In our own series, however, 16 patients in the senile arteriosclerotic group of 110 cases 13.6 per cent had positive Wassermann reactions and 12 of them were negroes. Two of the 45 diabetics, both negroes, also had positive tests, and we have no doubt that the number in both groups would have been materially increased had the past history of syphilitic infection been considered as well as the present laboratory manifestation.

Eliason's and Wright's statement that diabetic gangrene ensues approximately 10 years earlier than the arteriosclerotic variety we have found to be true as Figure 1 shows. The average age in the arteriosclerotic group was 64.2 years, 66.7 years for the white against 63.7 years for the colored while in the diabetic group the average age was 56 years, 64.5 years for the white against 51.9 years for the colored the discrepancy between the white and the colored age of onset being particularly striking in the diabetic group. In this same connection, it might be mentioned that the arteriosclerotics with positive Wassermann reactions exhibited their gangrene at an average age of 61.3 years and the diabetics at an average age of 42 years which is well below the average age for each group. The single patient with Buerger's disease who had a positive Wassermann reaction was only 28, although the average age for the group was 42.5 years.

Since the risk of surgery for gangrene increases with age it is not surprising to find (Fig. 1) that the average age of death in the arteriosclerotic group was 67.8 years more than 3 years more than the average for the whole group. The age

limits of the arteriosclerotic group ranged from 43 to 91 years, as contrasted with 37 to 84 years in Eliason's group, and from 31 to 74 years in the diabetic group, as contrasted with 34 to 79 years in Eliason's group.

The arteriosclerotic variety of gangrene is overwhelmingly more frequent in the male, 90 against 10 cases, while the diabetic variety is more frequent in the female 28 against 17 cases. All the cases of Buerger's disease occurred in white males. It is rather interesting that the average age of the females with arteriosclerotic gangrene was 69.2 years while the male age was considerably lower 63.4 years, and that in the diabetic group the average age of the female was 55 years against a male age of 51.3 years. The latter discrepancy is worth noting in view of Eliason's and Wright's conclusion that the female with diabetic gangrene runs more risk at an earlier age than does the male with the same condition.

Table I which shows the mortality in relation to the underlying disease is self-explanatory. From Figure 2, which shows the mortality and the development of secondary gangrene in relation to the site of amputation certain conclusions may be drawn. In arteriosclerotic gangrene if one is sure that the vascular occlusion is confined to the digital branches, conservatism can be safely

TABLE I.—MORTALITY IN RELATION TO DISEASE

Disease	Cases	Deaths	Mortality rate
Arteriosclerotic		43	50.6
Diabetic	45	19	42.2
Buerger	4	3	75.0
Embolic	2	2	100
Total	71	67	94.4

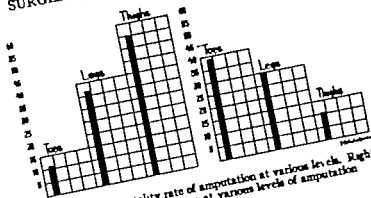


Fig. 2. Left, mortality rate of amputation at various levels. Right, incidence of recurrent gangrene at various levels of amputation.

practiced for the chances are that it will be successful and the risk of reamputation, though naturally greater is still not excessive. In the diabetic, on the other hand in whom the initial disease is more serious and in whom the tendency of the wound to heal is militated against by his constitutional disease the situation is much more serious it apparently cannot be taken for granted that the gangrenous process is localized, and reamputation carries with it a very serious risk. Finally the point we made originally is corroborated by these figures, that the higher the amputation is done the less is the risk of recurrent gangrene but the greater is the mortality. In Eliason's series reamputation in arteriosclerotic gangrene carried a mortality of 10 per cent against an original mortality of 34.2 per cent whereas in the diabetic group it carried a mortality of 50 per cent against a mortality of 35.1 per cent for the first operation.

The 14 cases of Buerger's disease deserve some special comment. In the 2 cases in which fingers or toes were amputated at intervals, there was no mortality. In the 7 cases in which amputation was done on the leg there were 3 recurrences, necessitating 2 reamputations, and there was 1 death from a streptococcal infection of the stump. In the 5 cases in which amputation was done at the thigh there was 1 instance of recurrent gangrene, and 2 deaths, 1 from lobar pneumonia in 4 days, and another 37 days after operation from an infection of the stump associated with pulmonary embolism and septic infarcts of the lungs, liver and kidneys. The high percentage of recurrences seems to prove the point made by a number of writers that amputation in this disease should be deferred until the limits of the process are clear.

Studying the mortality from the point of view of the time at which it occurred we find that 9 of

the 43 deaths in the arteriosclerotic group occurred within 24 hours, from shock, usually associated with toxemia, in 8 cases, and from cardiac failure in 1. Eight of the 19 diabetic deaths occurred within 24 hours from shock in 4 cases, the diabetes being under perfect control, and from diabetic coma in the other 4 associated, in 1 case, with a pre-existing gas bacillus infection. The immediate surgical mortality therefore in these two groups is 17.99 per cent, as compared with 3.6 per cent in Eliason's and Wright's 1936 series, and 3.5 per cent in Eliason's 1933 series, which includes only diabetics, this disproportion being rather interesting in view of the fact that the final mortality rates are not very different, 39.1 per cent for the Charity Hospital cases against 33.3 per cent for Eliason's arteriosclerotic cases, and 43.6 per cent for his diabetic cases.

Of the 19 arteriosclerotic deaths which occurred from 2 to 10 days after operation 10 were due to pneumonia, 4 to uremia, 2 to cardiac failure, 2 to recurrent gangrene and toxemia, and 1 to gas bacillus infection. Of the 7 diabetic deaths which occurred within the same period 3 were due to diabetic coma, 3 to recurrent gangrene associated in 2 cases with septicemia, and in 1 with pulmonary abscesses and otitis media, and 1 to pneumonia.

Of the 15 arteriosclerotic deaths which occurred after 10 days, 9 were due to pneumonia, 2 to cardiac failure, 2 to renal complications, and 2 to recurrent gangrene and toxemia. Of the 4 diabetic deaths which occurred in this period 2 were due to diabetic coma and 1 each to recurrent gangrene and toxemia and to myocardial failure and cerebral embolism.

To summarize and as Figure 3 shows, in the arteriosclerotic group shock and pneumonia were responsible for the greatest number of deaths, while in the diabetic group diabetic coma was

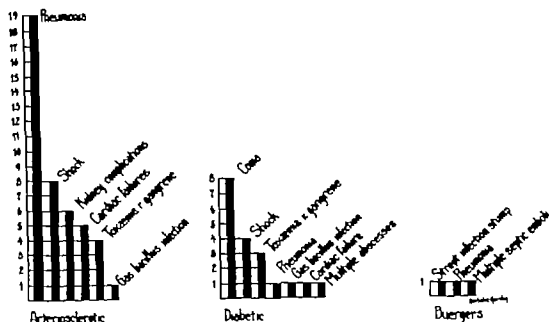


Fig. 3 Causes of death in various types of gangrene

responsible for almost 50 per cent. The contrast with the arteriosclerotic group is illuminating but rather shocking in these days when diabetic coma is supposedly a condition within medical control. Undoubtedly the explanation is the tendency of these patients to delay entrance to the hospital or to refuse surgery when it is offered to them. The last 2 diabetics who died on our own service died because they themselves refused operation until it was too late not realizing that in this disease the mere existence of gangrene and infection constitutes a threat to life and that the risk increases with every day that operation is postponed.

Only 2 cases in this whole series developed gas bacillus infection which was surprising to us in view of the 14 cases reported by Eliason 10 of them postoperative in his 175 cases. There is undoubtedly in this disease a sort of seasonal incidence our statistics end with December 31, 1933 and during January and February of 1934 we had on our own service 3 patients with gas bacillus infection following amputation 2 of whom died and the inclusion of whom would have materially altered our percentage. How or why these patients developed the infection we do not know though its occurrence in the cold months when blankets are in use naturally makes us think of Gage's brilliant work on the introduction of the infection from the contact of an open wound with woolen goods even after it has gone through all the processes of manufacture. That more of our colored patients do not develop this particular contamination is rather surprising for

the ward is overcrowded they have the most elementary ideas of hygiene and the soil seems ripe for it.

Certain explanations for our very high death rate immediately present themselves. Age is a factor which cannot be controlled and patients advanced in years with associated degenerative diseases of the heart and kidneys are bound to exhibit a higher mortality than younger subjects. Furthermore, they endure rest in bed badly, both before operation and after and are particularly prone to develop a hypostatic pneumonia which is likely to carry them off. This was recently proved by one of our own colored male patients. He entered the hospital in a deplorable state, which is not unusual, he refused operation for more than a week, and he developed a post operative gas bacillus infection which due to the carelessness of an interne was not reported to the staff man for more than 8 hours. For several days following the second amputation he was seriously ill and he weathered the postoperative storm only to lose his life 10 days later from a hypostatic pneumonia.

Our figures show that the duration of the gangrene provided toxæmia and infection are not associated factors, has surprisingly little effect on the mortality rate but that its extent (Fig. 4) is the most important single consideration in determining the outcome. For that extent as we have said several times, the surgeon is sometimes responsible but the patient more often is partly because he delays seeking medical advice partly because he refuses to follow the advice that is

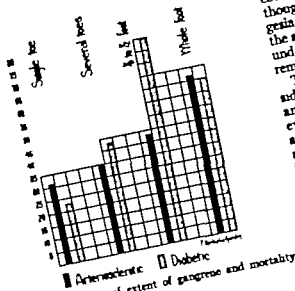


Fig. 4 Relation of extent of gangrene and mortality

given him. Once gangrene is established beyond hope of recovery the single most important factor in reducing the surgical mortality is the promptness with which operation is done. Two things cannot be too often emphasized that a diabetic operation is allowed to pass by and that neither may lose his life because the optimum time for operation is allowed to pass by and that neither diabetes nor aged arteriosclerosis tolerate toxemia well. The degree of the constitutional reaction seems almost as important as the extent of the gangrene. Eighty-two per cent of the patients who died in this series had a febrile reaction above 100 degrees F before operation while only 25 per cent who lived exhibited it the longer the reaction endured the higher the mortality.

Careful pre-operative preparation is essential. The preparation of diabetic patients is standardized and should be in the hands of the surgeon internist who works in full accord with the surgeon. Medical matters are the business of the internist but the surgeon must remember that when the diabetic is sick of other diseases, particularly diseases in which infection is a factor the usual reliance cannot be placed on insulin and his work must be done as expeditiously as possible. In the arteriosclerotic group as we have already mentioned, we have begun to study fall in the mortality since we have begun to study before operation the kidney function and general condition and to force fluids before and after operation. We are careful also to move these patients about in bed and to get them up as promptly as possible to guard both against pneumonia and against decubitus ulcers.

We do not believe that any death in this series could be attributed to the anesthesia used, although there seems no question that spinal analgesia or nitrous oxide or ethylene anesthesia is the agent of choice. Ninety-nine cases were done under spinal analgesia, 37 under ethylene, the remainder under local ether or nitrous oxide.

The type of amputation seems to have considerable bearing upon the recurrence of gangrene and the development of sloughs, which is to be expected for many of these patients have an actual or a latent infection when the operation is done, and postoperative infection is likely in any tissue in which the simple circular type of amputation is wisest for all amputations except those on the fingers and toes, and a careful study of these records convinces us of the correctness of our contention. This is the old *en sautoir* method of the French writers, which was described several years ago by Urban *Mac* in a paper on surgery in diabetics. The chief point of the operation is that the lines of section are made at right angles to the long axis of the limb which means, since the blood vessels of the extremities in passing to the tissue plane do so more or less at right angles, that no tissue is left without its blood supply. The procedure is quite simple technically. The skin is incised, then allowed to retract. The muscles are sectioned at the level of the retracted skin then allowed to retract. Finally the bone is sectioned at the level of the retracted muscle. To express it differently in each plane the section is made at a higher level so that the final effect is that of an inverted cone. With this technique with individual rather than *en masse* ligature, and with loose closure by three or four sutures over the face of the stump, it is rarely necessary to employ drainage.

SUMMARY AND CONCLUSIONS

1. Gangrene of the extremities in private and public practice introduces very different problems. A new conception of arterial vascular disease is essential on the part of both public and profession but the mortality is not likely to be reduced nor is the incidence of mutilating surgery until patients present themselves earlier for treatment and until physicians recognize the significance of premonitory symptoms.
2. One hundred seventy-one cases of varicose types of gangrene have been studied in detail with particular relation to the pathology exhibited, the predisposing causes, the racial incidence the mortality of amputation and the recurrence of gangrene after it.

3 The high death rate is attributed to delay in seeking treatment and in accepting surgery, and to the age and the concomitant cardiac and renal diseases of arteriosclerotic patients and the metabolic disease of diabetic patients the extent of the gangrene being the single most important factor. Anesthesia other than ether seems to play no part in the mortality, but the type of operation does, and the simple circular amputation is the one that is recommended.

REFERENCES

1. ELLIASON E. L. Surgery of diabetic gangrene. *Ann Surg* 1933, 98 : 16
2. ELLIASON E. L. and WRIGHT V. W. M. Diabetic and arteriosclerotic gangrene of the lower extremities. *Surg., Gynec. & Obst.* 1926, 42 : 753-768.
3. GAOK, I. M. Gas bacillus infection. A frequently unnoticed source of infection in civil life. With report of four cases. *Am J Surg* 1926, 1 : 177-184.
4. LEMANN I. I. Surgery in diabetes. New Orleans M. & S. J. 1926, 79 : 203-210.
5. Idem. Diabetic gangrene in the South. *J. Am. M. Ass.*, 1927, 89 : 659-661.
6. MAER, U. The surgery of diabetes as it concerns gangrene of the lower extremities and carbuncles. *Surg., Gynec. & Obst.* 1930, 51 : 700-704.
7. REID, M. R. Peripheral vascular disease. Diagnosis and treatment. *Am J Surg* 1934, 24 : 11-35.
8. SCOTT W. J. M., and BLOKROW J. J. Principles of treatment in the common arterial diseases of the extremities. *J. Am. M. Ass.*, 1932, 99 : 982-984.

A POSITIVE TREATMENT FOR FRACTURES OF THE SHAFT OF THE FEMUR

A PRELIMINARY REPORT EMPHASIZING AMBULATORY TREATMENT

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FRACTURE of the shaft of the femur presents a problem in mechanics which is often difficult of solution. The almost universal method of traction and suspension is far from ideal. There is no positive control of either fragment and accurate reduction is difficult and sometimes impossible. Frequent readjustment of the apparatus is essential to maintain position and requires almost hourly care. Long hospitalization is the rule and is a distinct economic drawback. Reduction and fixation by plaster cast is satisfactory in cases in which the fragments can be locked. Often however slipping and displacement occur within the cast. These considerations have led many surgeons to advise open reduction with internal fixation as a routine measure. Experience with a new method of treatment of fracture of the tibia and fibula has led to the development of a somewhat similar procedure for the femur. For fractures of the tibia and fibula counter traction is applied by a steel pin through the proximal fragment, and traction rotation and angulation by a pin through the distal fragment or os calcis. Incorporation of these pins in a plaster cast effectually prevents subsequent displacement. In the application of this principle to the femur traction and countertraction have been applied at the ankle and perineum. Pins through the proximal and distal fragments have been used only for manipulation and fixation.

Deformities in fracture of the femur are due to the fracturing force and to muscle pull. The latter replaces the former when the length of the limb is restored by traction and is, therefore, the more important (Fig. 1). The deformities are shortening rotation angulation and transverse displacement. They may be influenced by the direction of the fracture plane. Shortening is produced by the entire group of longitudinal thigh muscles and presents few difficulties if efficient extension is available. The proximal fragment is usually rotated outward, especially in high fractures, by the action of the external rotators of the hip. The distal fragment may be rotated in either direction by the weight of the foot but is usually everted. After the normal length of the limb has been restored and rotation corrected,

displacement may be viewed from anterior and lateral aspects. From the anterior aspect it is due to the action of the abductors of the hip and the adductors attached to the shaft. If the fracture is high the proximal fragment is abducted and the distal fragment adducted, thus producing outward bowing. If low the proximal fragment is often adducted in relation to the distal fragment which is held in line by traction. From the lateral aspect the deformity is due to anterior flexion of the proximal fragment by the iliopsoas and posterior flexion of the distal fragment by the gastrocnemius group. Flexion of the proximal fragment is most marked in high fractures and of the distal fragment in low fractures.

The first principle of the usual non-operative treatment is to restore the length of the limb by extension. This corrects transverse displacement by the squeezing effect of the taut musculofascial tube in which the bone lies. The second principle is to bring the distal fragment into line with the proximal, leaving them both in their positions of muscle equilibrium. This is accomplished from the anterior aspect by abducting or adducting the distal fragment. From the lateral aspect the lower fragment is brought into line by flexing the knee to relax the gastrocnemius and lifting the fragment anteriorly to appose it to the flexed proximal end. Rotation is easily controlled by various means. Maintenance of the fragments in this position is then attempted by continuous traction or a plaster cast.

The method here presented gives accurate mechanical control of the proximal as well as the distal fragments. Firm, uninterrupted fixation is provided until healing occurs. The position is that of normal weight bearing rather than that of muscle equilibrium. Immediate ambulatory treatment is possible. The latter is important aside from the economic advantage of short hospitalization. Weight bearing encourages healing and prevents to a large degree the atrophy associated with immobilization. The natural physiotherapy obtained by the use of the extremity is superior to any form of artificial physiotherapy in maintaining the nutrition and tone of the tissues. When a walking cast is removed the strength of

the extremity and the range of motion at all joints is often surprising. It is not unusual to have immediate complete range of motion at the hip and ankle and 45 degrees of painless active motion at the knee. Measurement of the circumferences of the thighs and calves show little or no atrophy. This is superior to the state after removal of the usual padded, non-ambulatory cast, and at least equal to that following traction suspension methods.

PROCEDURE

1. Under spinal or local anesthesia the patient is placed on the fracture table and extension applied until the length of the limb is restored. This is obtained by Collin's hitches about the ankles and countertraction against the ischium of the well side.

2. After preparation of the skin a steel pin, $\frac{1}{8}$ inch in diameter and 6 to 8 inches long is inserted transversely through the distal fragment just above the adductor tubercle. A second pin, $\frac{5}{32}$ inch in diameter and 8 to 10 inches long, is inserted in the anteroposterior direction at or slightly below the level of the lesser trochanter. If placed above this point, the soft cancellous bone will not stand the strain imposed upon it. This pin is well lateral to the femoral vessels and sciatic nerve, the only important structures in this region. Accurate placement is best aided by the fluoroscope. These pins are inserted directly through the skin. Incisions are unnecessary and invite infection. Restoration of the length of the limb before insertion of the pins is important to prevent skin tension. Small alcohol or collodion dressings may be applied about the pins.

3. The distal pin is slung from the suspension bar of the table by a suitable caliper and lifted to correct flexion of the distal fragment. Flexion of the proximal fragment is corrected by a clockwise motion of the upper pin which is held manually in a caliper (Fig 1a). From the anterior aspect the deformity is corrected by abduction or adduction of the distal fragment combined with medial or lateral traction on the proximal pin (Fig 1b). Rotation is corrected by appropriate motion of one or both pins.

4. The position is checked by fluoroscopy or roentgenograms in two planes and any necessary residual correction carried out. It is occasionally advisable to overextend the extremity during manipulation so that there is a space between the fragments. This facilitates reduction in irregular fractures, but as soon as proper position is obtained traction should be decreased so that the fragments firmly abut each other.

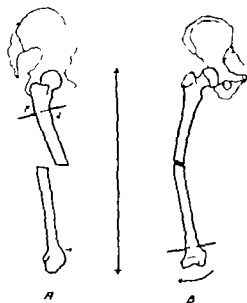


Fig 1. The usual displacement in fracture of the shaft of the femur after length of the thigh has been restored viewed from A, the lateral aspect and B the anterior aspect. The sites and positions of the pins are indicated. Arrows show the directions in which force is applied to the pins for reduction.

5. A non-padded walking spica is applied following the method outlined by Boehler and Schnek. The anterior superior spines and sacrum are protected by thin padding which is covered by a circular layer of flannelette extending from the xiphoid to the symphysis. A previously prepared roll of padding is applied to the tuberosity of the ischium for counterpressure. This is made by tightly rolling an 8 by 5 inch oblong of silence cloth over the center of a 3 foot length of bandage and covering it with adhesive tape. The pad is about 8 inches long and the thickness and firmness of a Thomas splint roll. The long ends of the bandage are pulled snugly upward over the flannelette so that the pad impinges firmly against the tuberosity. Circular plaster bandages are applied to the trunk and pelvis and molded about the crest and spines of the ilium. Anterior and posterior splints are applied to the skin from the Collin's hitch well up over the pelvic portion of the cast and covered with circular plaster bandages closely incorporating both pins. On the perineal side of the thigh, plaster is modeled over the ischial roll to form a shelf like structure which holds the roll in place and transfers some of the pressure of weight bearing to the ischium after the manner of a Thomas walking caliper. The remainder of the weight is taken up by the pins. The junction of the thigh and pelvic portions of the cast is strengthened by additional splints and bandages. When this plaster has set the Collin's hitch is removed and the cast extended.

An anterior plaster splint is applied as far as the base of the toes and a posterior one to a point $\frac{1}{4}$ inch beyond the tips of the toes. These are covered with circular plaster making firm union with the rest of the cast. A Boehler walking iron is incorporated as soon as the plaster has hardened. Trimming of the cast is carried out to uncover the upper abdomen and allow free motion of the uninjured thigh. Accurate and proper molding of this type of cast is essential, especially about the pelvis, knee, and ankle. One should have considerable experience with the smaller non-padded casts before attempting a spica. The cast should be as light as is consistent with strength. Properly constructed for an adult of average size it weighs 12 to 14 pounds, and is considerably stronger than an equally heavy padded cast on account of the more evenly distributed stresses (Fig. 2, 10, 13).

6 Weight bearing is allowed as soon as the plaster is sufficiently hard and roentgenograms have checked position in the cast. In healthy young adults and children this is usually about the third day. Two crutches are used at first, later to be exchanged for canes as the patient gains confidence. Children not infrequently require no external support after a week or two. Weight bearing should be painless after the first few days. If it is not there may be some defect in the cast or reduction. The most probable cause of pain is insufficiently firm fixation of the pins in the cast allowing motion. The cast remains in place throughout the period of healing and may take the place of a convalescent walking splint. The pins may be removed at the end of about 8 weeks.

7 Feeble elderly individuals may be too weak to carry a cast and so not able to avail themselves of the advantages of ambulatory treatment. In this case the pelvic portion of the cast may be omitted or removed leaving the ischial pad and maintaining firm fixation of the proximal pin. It is possible that pivoting of the proximal fragment on the pin might occur with resulting outward bowing. This has not occurred in two cases so treated, but I feel that omission of the pelvic cast is advisable only if the patient cannot walk, and when it is essential to allow him to sit up in bed or a wheel chair.

APPLICATION OF METHOD

Putti has utilized a method for operative lengthening of the femur in which he places proximal and distal pins for traction and counter traction. It should be noted that in the technique for fractures described in this paper no traction

is applied to the pins so that they are left perfectly free for manipulation. The evolution of this method of treatment was necessarily gradual. The reduction of suitable fractures by manipulation and fixation in a spica cast was the natural starting point. The first additional step was to correct the posterior angulation of the distal fragment in fractures of the lower third of the femur by a steel pin as described by Anderson. In cases so treated bowing was found to occur with weight bearing. This was due to settling of the thigh into the cast despite the ischial pad (Case 1). The next development was skeletal control of the proximal fragment making the method applicable to all fractures of the shaft and effectively preventing displacement or bowing. "Mechanical hands" which may be firmly attached to arms from the table have been designed to manipulate and hold the pins until the plaster has set. These will eliminate the cumbersome method of hanging the distal pin from the suspension bar of the table by a rope and manually controlling the proximal pin. Some surgeons are not familiar with or are not convinced of the advantages of the non-padded cast and ambulatory treatment. For their benefit the pins may be used with the padded type of cast, adding the advantages of accurate reduction and firm fixation to their previous techniques.

This method has been applied to 10 cases. Five of these were not made ambulatory because of psychosis (3 cases), other fractures (2 cases), and transfer to another hospital shortly after reduction (1 case). The 5 other patients first walked with weight bearing on the second to the fifth day except one patient with a compound (gunshot wound) fracture who walked on the eighth day following fracture and the first day after application of plaster. Healing in good position with excellent functional result is known to have occurred in all these cases except the one transferred elsewhere. Hospitalization has been reduced to a minimum, averaging about 12 days for patients who did not have co-existing disease or injury for which hospitalization was required. The following cases have been selected to illustrate (1) anterior bowing due to weight bearing when the proximal pin was not used (Case 1), (2) use of the procedure when the patient cannot be made ambulatory (Case 2) and (3) typical ambulatory treatment (Cases 3 and 4).

CASE REPORTS

CASE 1. A P. aged 28 years, Hospital No. A 7464, was admitted with an irregular transverse fracture at the junction of the lower and middle thirds of the left femur with acute posterior angulation of the distal fragment and no



Fig 1

Fig 3

Fig 4

Fig 5



Fig 6

Fig 7

Fig 8

Fig 9

Fig 10

Fig 2 Case 1: A plaster spica 1 month after ambulatory treatment was begun. The distal pin is shown covered with cork and plaster. Note the counterpressure pad at the groin.

Fig 3 Case 1: Fracture of lower third of femur with typical displacement. No proximal pin was used in this case.

Fig 4 Case 1: The fracture has healed, but bowing occurred as the result of settling of the upper fragment in the cast.

Fig 5 Case 1: Function at the end of 5 months. Anterior bowing is clearly shown.

Fig 6 Case 2: Fracture of middle third of femur and multiple fractures of other bones prevented ambulatory treatment. Treated with 2 pins.

Fig 7 Case 2: Position and healing at the end of 4 months. The site of the distal pin is clearly visible.

Fig 8 Case 3: An oblique fracture of the upper third of the femur with minimal displacement. Co-existing arthritis of the hip is also shown in Figure 9. Ambulatory treatment with 2 pins.

Fig 9 Case 3: Position and healing at the end of 3 months.

Fig 10 Case 3: Patient walking on crutches 1 week after injury.

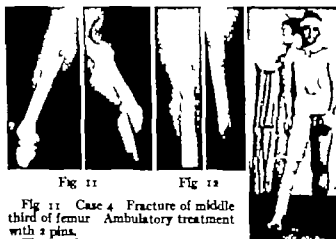


Fig 11

Fig 12

Fig 13

Fig 11 Case 4: Fracture of middle third of femur. Ambulatory treatment with 2 pins.

Fig 12 Case 4: Position in cast during ambulatory treatment.

Fig 13 Case 4: Note molding of cast about the ilium and the plaster shell covering the counterpressure pad. The covered end of the proximal pin is shown opposite the lesser trochanter. The distal pin is clearly visible.

position (Fig. 3). Under spinal anesthesia the length of the limb was restored by traction on the Hawley table and the displacement corrected by manipulating a steel pin which was passed through the distal fragment. A Boehler spica was applied incorporating the pin. He was allowed up on crutches on the fourth day and discharged on the eleventh day. Roentgenograms at this time showed acceptable alignment and position except for some anterior bowing. At the end of 1 month he was walking well with two canes (Fig. 2) and there was good callus. The pin was removed on the fifty-eighth day and the cast on the seventy-fourth day. At this time union was firm, there was 90 degrees of motion at the hip, 45 degrees at the knee, and complete function of the ankle. There was no shortening. At the end of 5 months, the function of the hip and knee was normal (Figs. 4 and 5).

CASE 2. K. K. aged 15 years, Hospital No. 3, 157 was admitted with a transverse fracture of the middle third of the left femur with 5 inches of overriding (Fig. 6). There were associated fractures of the left superior ramus of the pubis, the middle third of the right tibia and fibula and the first, second and third metatarsals. Under spinal anesthesia the fracture of the right leg was reduced and placed in non-padded plaster cast. Traction was applied to the fractured metatarsals by wires passed through the pulps of the toes and rubber bands fastened to an outrigger on the cast. The length of the left thigh was restored to normal by traction on the Hawley table. A steel pin was passed transversely through the distal fragment at the level of the adductor tubercle and another in an antero-posterior direction opposite the lesser trochanter. The fracture was reduced by manipulation of these pins and a non-padded spica was applied. Post reduction roentgenograms showed satisfactory position of all fractures except slight deformity of the distal extremity of the second metatarsal. He was discharged home on the seventh day. He was readmitted for one day on the twenty-fourth day for removal of the wire traction from his toes and repair of the spica which had cracked at the groin. On the sixty-fourth day he was readmitted for 2 days and the casts and pins were removed. There was good union of all fractures but slight lateral angulation of the tibia. When seen again at the end of 4 months he was walking well without support with a slight limp but no pain. The thighs were of equal length but there was 1/2 inch shortening of the right leg and a right pes planus. Flexion of the right knee was complete. The left knee was limited to 90 degrees. The range of motion of hips and ankles was complete. There was firm healing and good position (Fig. 7).

CASE 3. E. B. aged 42 years, Hospital No. 32, 504, was admitted with an oblique fracture at the junction of the upper and middle thirds of the right femur with 1 inch overriding (Fig. 8). Reduction was carried out in the usual manner on the Hawley table under spinal anesthesia, 2 pins being used and incorporated in a walking spica. She was allowed up on crutches on the third day (Fig. 9) and discharged home on the eighth day. The pelvic portion of the cast was removed on the forty-fourth day. The pins and remainder of the cast were removed on the sixty-fourth day. At this time union was firm. She continued up on crutches. At the end of 3 months she was walking well and had good union with slight anterior bowing. There

was 90 degrees range of motion at the knee. Limitation of the hip was considerable as a result of pre-existing arthritis (Fig. 9).

CASE 4. A. B. aged 20 years, Hospital No. 33, 580, was admitted with fracture of the middle third of the right femur with 2 inches of overriding (Fig. 11) and multiple lacerations. The lacerations were debrided and sutured and traction applied to the injured thigh under spinal anesthesia on the Hawley table. Pins were inserted through both fragments in the usual manner, the reduction completed, and a Boehler spica applied. He was allowed up on crutches on the third day (Fig. 12) and discharged home on the tenth day. Roentgenograms showed satisfactory position (Fig. 13). He was readmitted on the sixty-fourth day on account of a carbuncle near the edge of the medial pad. The pins and cast were removed to allow incision and drainage. Position was good, but union was not yet firm enough for unsupported weight bearing. Three weeks later the carbuncle was healed and union was strong enough to allow walking on crutches with guarded weight bearing.

CONCLUSIONS

1. A new method of positive mechanical reduction for fracture of the shaft of the femur is presented.
2. Firm, dependable fixation is maintained throughout the period of healing.
3. Ambulatory treatment is feasible giving the advantages of continuous physiotherapy.
4. Anatomical and functional results in a small series have been excellent.

Since this paper was submitted for publication June 11, 1934, McWhorter has reported the use of a pin through the greater trochanter which is fixed in plaster after reduction of the fracture on the Hawley table. His key has also described an apparatus for applying skeletal traction and counter traction to the femur with pins in both fragments. Further experience with the method I have described leads me to believe that it is important to restore the length of the limb before inserting the pins. This will prevent pressure necrosis of the skin about the pins. It is also advantageous to leave the pins free of traction force to allow easy and accurate manipulation.

REFERENCES

1. ANDERSON, ROGER. *Ann. J. Surg.* 93: 18, 36-39.
2. BOEHLER, LORENZ. *The Treatment of Fractures*. Vienna: Wilhelm Maudrich, 1932.
3. GRISWOLD, R. A. *Surg. Gynec. & Obst.* 1934, 58: 907-908.
4. IDEM, J. *Am. M. Ass.* 935: 104, 15, 40.
5. HAWLEY, GEORGE W. *J. Bone & Joint Surg.* 1934, 16: 976-980.
6. McWHORTER, GOLDEN L. *Surg. Clin. N. America*, 1934, 4: 887-891.
7. PUTTI, VITTORIO. *Surg. Gynec. & Obst.* 1934, 59: 315-321.
8. SCHRELL, FRITZ. *The Technique of the Non-padded Plaster Cast*. Vienna: Wilhelm Maudrich, 1931.

THE CLOSURE OF CHRONIC OSTEOMYELITIC CAVITIES
BY PLASTIC METHODS

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A SIMPLE serviceable measure for effecting healing in bone cavities is by skin grafting first used by the writer in 1901 before either saucerization or skin grafting was recommended or popularized (3).

Figure 2 represents a bone cavity in an acetabulum and the partially excavated head and neck of the femur in a woman 60 years of age who had had a discharging sinus for 50 years due to hip disease from infancy. In later years it had become a large persistent residual abscess because the innumerable curettings and excavations resulted in its progressive enlargement thus decreasing the possibility of healing the putrid bony cavern. The cavity which was 7 centimeters deep was healed by the introduction of plastic skin flaps, and supplemented by skin grafts. The method employed resulted in the permanent healing of this almost life long problem case (Fig. 2B).

Among the simplest of the defects to be closed following operations for osteomyelitis is the gutter remaining in the tibia due to the removal of the diseased tissue of the anterior and interior portions of the bone after it has been saucerized. The gutter may be long or short. It sometimes extends the whole length of the tibia.

It is represented in the upper third in Figure 4. The common textbook treatment of this condition is to gutter the bone—that is to excise by saw and chisel the diseased portion and remove sufficient of the cortex to render the cavity more shallow after which our usual method is to turn in the skin edges to meet at the bottom of this gutter to cover the bone surfaces and thus effect early healing and closure.

In some chronic cases in which operation had previously been done, greatly enlarged bones sometimes covered with extensive exposed scars had frequently become abraded and ulcerated. Having seen 2 cases of cancer develop from such scars repeatedly traumatized I have had a wholesome fear of allowing a workman to carry such a scar on the surface of his shin. In the case of a greatly enlarged osteomyelitic tibia, many times recurrent (not here illustrated) there was a wide scar area of parchment like ulcerated skin which necessitated wide excision after which there was insufficient sound skin to fill the usually wide gutter completely. Therefore their

margins were freely undercut but still their edges would not meet at the bottom of the gutter with out too much tension. Lateral incisions were therefore made and undercut to release the flaps so that the skin margins would coapt. For fastening these skin edges I commonly use carpet tacks of a large size or small nails or brads after the method of Neuber. Sometimes however the bone is so hard and eburnated that an ordinary tack may be broken off in which case it may be necessary to make small drill holes to receive the brads or tacks. The remaining lateral skin defects after relaxation cuts if wide may also require skin grafting in case they cannot be later coapted by the sutures primarily left untied (Fig. 3A).

Figure 4 represents a persistent cavity in the upper end of the tibia. A large perforating defect extended through the tibia to a sequestrum behind the bone thus leaving a very large cavity difficult to fill. Nature will begin the closure of such a large cavernous defect in the interior of the bone by granulations and succeed to a certain point, but there will remain an infected cavity or sinus, persistent sinuses may remain indefinitely. Recureting fails, because the cavity may have become too large to be healed unaided by nature's processes, and it must be filled by transferring tissue. Where transfer of muscle and other tissue was too difficult and impracticable I have effected healing in some of these cases as follows. By the incisions as shown in Figure 4A, flaps were made from above and below which were turned into the excavated area (Fig. 4B). This technique was used after the cavity had been débrided and lined with granulations. The interior was healed by these skin flaps and a dry cutaneous tract secured by adopting the principle of Beck, which was used by him in the treatment of extensive empyemas. These flaps were turned into the cavity the skin surfaces facing each other but not in close contact. Thus a skin lined tract was secured and the coapted flap margins rapidly healed. The opening having been circular these margins were readily brought together and a permanent healing obtained. These procedures reduced the period of hospitalization to a minimum. One such patient had been afflicted for 14 years. A sequestrum in the upper portion on the

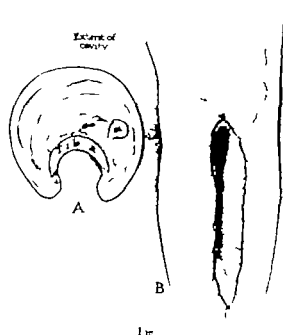


Fig. 1

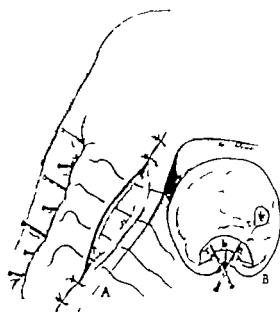


Fig. 3

posterior surface of the tibia, had left a large tunnel through the bone from eight previous operations which resulted in successive increases in its size and presented a perplexing problem. The procedures here outlined turned out very well in these cases. Thus seemingly incurable discharging bone cavities were finally and permanently healed in a satisfactory manner. The cavities in the tibia were too high and inaccessible for muscle flaps. The skin-lined tracts (Fig. 4C) gave no inconvenience.

Figure 5 illustrates the preparation of an extensive cavity in the femur and shows the method of securing the flaps. This technique is not new but from my observation is little practiced. It is

my conviction that a person who has had osteomyelitis for 10 or more years, with discharging sinuses and recurrences every year or two, is entitled to an early expeditious and permanent cure if such is possible of achievement. The removal of the diseased and infected area in cases of long standing by careful excision, leaves little chance for contamination and, if infection does occur it should lack virulence after years of self-immunization. For these reasons, liberties may be taken in making immediate closures. Therefore it has been my custom to make primary plastic closures by securing tissue as shown in Figure 6A, and turning the flaps of fascia, fat, and muscle secured from the median and lateral thigh surfaces, into the cavity, closing the skin flaps over all in one procedure. (Fig. 5B and C). In some extensive cases, in which the process involved the whole of the interior of the shaft, as shown in Figure 6A it has been necessary to turn in tissues from both sides and appose the deep flaps, filling the large cavity completely and closing the skin as in Figure 5B.

The following case, a still more extreme one of the type just described, will demonstrate its fuller extent. The process invaded one-half of the femur and involved the condyles to such a degree that the disease extended to the cartilages, and there remained but shells of the condyles. Ankylosis of the knee had resulted from the effects of the disease, which had existed for 24 years. The

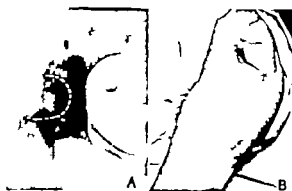


Fig. 2

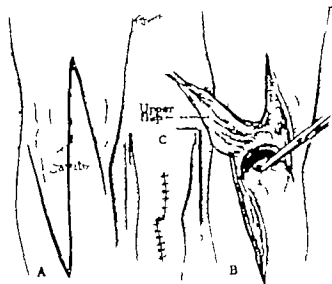


Fig 4

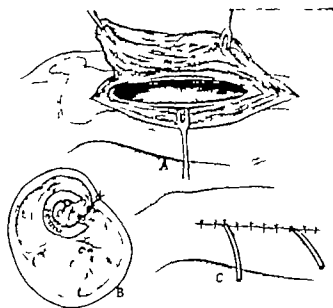


Fig 5

apices of the flaps composed of fat ligaments and underlying soft parts over the ankylosed knee joint including periosteum over the condyles and tuberosities of the tibia, provided extra length to the flaps of the vastus internus and externus. The extra length of these very long flaps was secured by extending the longitudinal incisions in the skin and ligaments below the knee joint 1 5 inches the skin had been reflected and deep flaps of fat, fascia, and periosteum were taken from the lateral surfaces of the ankylosed knee. The femur and condyles had been completely excavated from both sides. These long flaps were then turned from each side into the hollowed lower femur and folded transversely within the cavity of the condyles so as to fill completely this portion of the very large space. The fascia, aponeurosis and muscles were sutured together as well as to the wound margins to prevent their retraction. Thus, by using these large amounts of additional soft tissues to elongate the flaps of the vastus muscles the enormous cavity in the lower half of the femur and extending into the condyles was filled. Aided by dakinization delayed or delayed primary union was obtained. Figures 6A and B illustrate the method of closure and Dakin tubes as shown in Figure 5C.

In earlier work I regularly introduced Dakin tubes and to prevent their immediately becoming clogged with clots which would nullify their efficacy it was my custom to start irrigation immediately with a 2 per cent solution of sodium citrate and continue it until the Dakin irrigation was established in order to be sure of having patulous tubes. By employing this technique in these

cases a sterile wound was maintained and healing by delayed or delayed primary union was immediately accomplished, permitting the discharge of the patient in 3 weeks. The patient with the severe condition referred to has remained well Previous to being treated as outlined this man had suffered from constantly discharging sinuses with recurrences every year or two for a period of 24 years. In a similar case the wound closed promptly after 35 years of sinuses and recurrences. A series of 16 cases somewhat alike have been thus successfully closed by what I have termed delayed primary healing.

These operations may vary in degree according to the extent of the disease and must necessarily

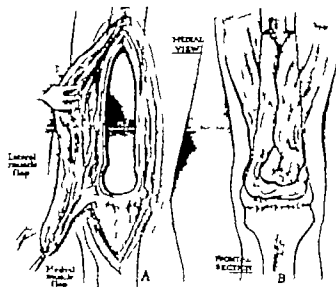


Fig 6

vary in their application. I have found dakinization very useful in many cases, but in some of the more chronic cases I have not used it. I have simply coapted the wound rather loosely and left it patulous, and have succeeded without dakinization. It is a matter of judgment as to whether or not one need employ Dakin's solution. In a few cases, hypertonic salt solution has furnished a satisfactory substitute. Needless to say, my judgment has failed me in some cases in which I had become too bold, and had used no antiseptic irrigation.

The plastic closure of osteomyelitic cavities by bone and soft tissue, I repeat, is not new. Experience has led me to use it in the manner described with variations in selected cases, and the results have been obtained by a primary loose closure of the cavity rather than by a period of primary dakinization and closing by a secondary procedure.

One of my principal objects in this work has been to limit the stay of the patient in the hospital and secure an early permanent healing.

In the late war it was found very desirable to treat wounds with Dakin's solution after débridement and when the field became clean the plastic work was done as a secondary operation. In civil

life, many of our cases are of the chronic form, and repeated operations have been done, the patients having gotten well of the acute disease, but continuing to be harassed by recurrences or by draining sinuses. As previously stated, it is my conviction that such long suffering individuals are deserving of permanent cure and that the operations, therefore, should be radical if necessary to effect it. In the chronic cases, when infection is not particularly to be feared and the patient has become presumably relatively immune from the remaining organisms, one may in a primary operation do the excavating and plastic closure as one procedure and secure, at least delayed primary union. In chronic osteomyelitis involving the whole interior of the bone whether it be of limited or great extent the cavity may be filled by muscle and fat and sometimes bone, after thorough removal of the disease. The complete closure and healing of the wound in some cases need not require more than 10 days or 2 weeks.

REFERENCES

1. Beck, E. C. Arch Surg 1923, 8, 327-330.
2. Loun, JOHN PIERCE. Am. M. Ass., May 31, 1903, 35, 1433-1434.
3. Nicolson, G. Arch f. Clin. Chir. 1895, 31, 683-716.

OPERATIVE INJURIES OF THE URETER¹

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ALTHOUGH a review of the literature reveals numerous reports of operative injuries of the ureters it is probable that relatively few cases are recorded. This discussion deals briefly with the treatment of some types of such injuries and is based on the observation and treatment of 5 cases.

In considering the question of operative injury of the ureter either from the standpoint of prevention or treatment, the important thing to be kept in mind is the preservation of renal function. Before entering upon a discussion of the treatment of these injuries means of preventing them should be mentioned. The presence of a catheter in the ureter during difficult operations in the pelvis will make it possible easily to avoid the ureter. For many years we have routinely inserted catheters in the ureters of such patients for the Department of Gynecology at the Wisconsin General Hospital and as a result only one ureter has been damaged (Case 4 of this series). In this case serious pathology was unexpectedly encountered and catheters had not been introduced.

In treating these injuries the genito-urinary surgeon encounters many difficult problems. The variations depend upon the age of the injury, its distance from the bladder, whether one or both ureters are involved and the type of injury, that is, whether it is completely severed, completely severed with the removal of a segment, partially severed, ligated or clamped. Suddenly confronted with the problem of dealing with a severed ureter many surgeons adopt the procedure of ligation as the best way out of the dilemma. Embarrassing circumstances are in this way avoided in many cases, but a kidney is rendered functionless. Further in some cases this treatment results after a lapse of a few days in urine draining from the ureter into the peritoneal cavity, or possibly finding its way to the outside, or infection in the kidney may necessitate surgical interference. The ligation of a cut ureter under circumstances favorable to repair should receive our most severe condemnation.

The method of repairing the ureter when the injury is discovered at the time of operation is for obvious reasons of the greatest importance. However, since the genito-urinary surgeon is rarely present when the injury occurs he will seldom have to deal with this situation. Simple ligation is justified only when the condition of

the patient is too bad to permit an operation for repair, for which, of course, more time is required.

A large number of operations have been described for the repair of this type of injury, but all are based on the principles of end-to-end, end-in-end or side-to-side anastomoses. As this operation will always be infrequently performed a simple method should be adopted and its principles thoroughly understood so that when called upon to repair a ureter the surgeon will not have to use a technique with which he is not thoroughly familiar. My first opportunity for repairing a severed ureter came suddenly. Fortunately a satisfactory repair was made and a normally functioning kidney was obtained (Case 1). Afterward in looking up the subject I found that I had adopted the technique described by Dr. Hugh Young. This technique seems to combine the principles of simplicity, splinting of the ureter, maintenance of caliber and satisfactory drainage. It is, I believe, the technique of choice for the repair of these ureters with certain exceptions which will be mentioned later. The technique is as follows:

A ureteral catheter as large as will freely move through the ureter without interfering with the circulation is introduced into the ureter and passed into the kidney pelvis. Introduction may be made through a cystoscope or the catheter may be passed each way from the point of injury, the lower end being brought out through the urethra later. Over this catheter end-to-end anastomosis is made with fine catgut, the sutures being passed through the serous and muscular layers. With satisfactory drainage the catheter may be left in place for many days to prevent contraction of the lumen during healing.

Exceptions are to be made when (1) the injury is sufficiently low to permit reimplantation into the bladder which is preferable or when (2) a segment has been removed of sufficient length to cause tension. If there is tension satisfactory healing will not occur and implantation into the bowel is the operation of choice.

In old injuries every case is a law unto itself. After appropriate examinations to determine the condition of the kidneys and ureters a satisfactory procedure must be selected. This may be a plastic repair, implantation into the bladder or bowel, nephrostomy or nephrectomy.



Fig. 1. Intravenous urogram made nearly 5 years after left ureter was completely severed and repaired. The kidney pelvis and ureter appear normal. Case 1.

CASE 1. Mrs. J. N., white female aged 24, was operated upon, April 9, 1929, by a general surgeon for an inflammatory mass of long standing which was located in the left side of the pelvis, having originated in the left fallopian tube. During the course of the operation it was discovered that the left ureter had been severed. Being in the hospital at the time, I was called, and with the wound still open passed a direct cystoscope into the bladder and introduced a No. 6 catheter into the left ureter. When this catheter reached the point of severance the surgeon introduced it into the proximal end of the ureter and it was passed to the kidney pelvis. The ends of the ureter were then anastomosed—end-to-end—with fine chromic catgut sutures, which were passed through the serous and muscular layers. There was never any leakage of urine at the point of anastomosis. The catheter was removed on the tenth day. Convalescence was smooth and uneventful. The patient was discharged from the hospital on the twentieth postoperative day in good condition. She has been seen at intervals since and has at no time had any symptoms referable to the kidney, and the urine has been normal. She was last seen in February, 1934, when she came for examination at my request. She was free of symptoms, the urine was negative, and intravenous urograms showed normal kidney pelvis and ureters.

CASE 2. Mrs. B. was operated upon by a general surgeon, August 1933, for the removal of an ovarian cyst. About 4 centimeters of the ureter which was attached to the wall of the cyst were removed. I was called at the time and inserted a No. 12 catheter through a cystoscope as described in Case 1. The ureter was repaired as in Case 1 but with considerable tension due to the removal of a piece of the ureter. On the seventh day a small amount of urinary drainage was noted on the dressing. There was no further drainage, and recovery seemed uneventful. The



Fig. 2. Retrograde urogram (reversed) showing normal right kidney and extra-urinary mass on left. This was made more than 2 months after the injury, the ureter having been repaired and the catheter left in the ureter for 15 days after the operation. Case 2.

catheter which had drained freely was removed on the fifteenth day and the patient went home on the nineteenth day with the wound well healed. Ten days later, however, she developed symptoms of frequent and painful urination and the urine was found to contain considerable pus. She was treated for several weeks with bladder lavage and urinary antiseptics, but was returned to the hospital on October 31, 1931, when she had a chill, fever and pain in the right side of the abdomen. On cystoscopic examination the right kidney was found to be infected with *Escherichia coli*. No urinary spurt was seen on the left side and though the left catheter apparently passed to the left kidney the urogram indicated that it passed into the per-ureteral tissues at the point of severance where it was coiled. The proximal end of the ureter apparently healed with occlusion as an intravenous urogram showed no evidence of flow in the left kidney pelvis and ureter.

CASE 3. Mrs. H. K., a white female, aged 45 years, had a vaginal hysterectomy and repair of cystocela by a general surgeon on March 24, 1931. Following the removal of a vaginal pack urine was noted from the vagina. From cystoscopic and other examinations it was determined that this was due to an injury to the left ureter. On October 7, 1931, through a left rectus incision the left ureter was isolated, freed, and re-implanted into the bladder. Convalescence was uneventful and the patient was discharged from the hospital on the twenty-first day in good condition. The patient has been seen at intervals since and has been free of symptoms referable to the urinary tract. She was last examined on April 15, 1934, when she was free of symptoms and the urine was normal. An intravenous urogram at that time showed good function in both lobes and very little dilatation in the left pelvis.



Fig. 3. Intravenous urogram 3 years after reimplantation of injured left ureter into bladder. The pelvis, calyces, and ureter are normal or very slightly dilated. Case 3.



Fig. 4. Intravenous urogram showing the presence of hydronephrosis on the left side which was the side injured. Case 4.

CASE 4. Mrs. C. M., a white female aged 46 years, was operated upon by a gynecological surgeon in November 1930, for a very large fibroid tumor. When ligating the left uterine vessels a structure thought to be a severed ureter was encountered. It was ligated, the abdominal wound was closed, and vaginal drainage instituted. A few days after operation urine began to drain through the vagina. Four weeks after operation an intravenous urogram revealed a large left hydronephrosis. A left nephrectomy was performed. Convalescence was uneventful. As large aberrant vessels were found going to both poles of this kidney it is probable that the vessel to the lower pole was at least partly responsible for the hydronephrosis.

CASE 5. A white female, aged 38 years, was first seen on June 24, 1931. She presented a letter from her local physician who stated that he performed an operation in March, 1931, for the removal of cysts from both broad ligaments. The left ureter was cut and repaired by invaginating the proximal end into the distal end. The wound healed but 10 days after discharge from the hospital severe chills and fever occurred, the wound re-opened and urinary drainage was noted. This continued. When we first saw the patient she was very acutely ill with temperature 103-104 degrees, chills, fever, nausea, and vomiting. There was free urinary drainage through the old abdominal incision. Urine was voided regularly. On cystoscopic examination urine was seen spurting from the left ureter and indigocarmine appeared in 9 minutes. A catheter met an impassable obstruction 3 inches above the bladder. No urine was seen coming from the right ureter and indigocarmine did not appear. A catheter met an impassable obstruction 5 inches above the bladder. A diagnosis was made of complete occlusion of the right ureter, probably the result of ligation, and left uretero-abdominal fistula, part of the urine from the left kidney draining into the bladder and part through the fistula. Operation was

performed on July 14, 1931. The left ureter was located and was found to be firmly adherent to the iliac artery for a distance of 1 1/4 inches; this was carefully dissected free. The fistulous tract which passed through the abdominal



Fig. 5. Retrograde pyelo-ureterogram, right. Case 4.



Fig. 6 Intravenous urogram. The left pelvis, calyces, and ureter are moderately dilated. No dye was excreted by the right kidney. Case 5.

cal cavity was dissected from the ureter and the peritoneum was closed. The ureter was then opened above the strictured area and the structure was widely dilated. Through the opening in the ureter a No. 10 catheter was passed upward to the kidney pelvis and downward through the bladder to the outside. The ureter was sutured and the wound closed with drainage. As a result of the free drainage the patient's condition in a few hours was better than before the operation. The catheter drained freely and in large quantities and there was no urinary drainage on the dressings. The patient died suddenly on the third post-operative day apparently from an embolus, though this could not be confirmed as autopsy was refused.

There are in the literature many case reports in which it is assumed that a satisfactory result has followed a ureteral repair but few in which the question is proved by appropriate follow-up examination. In 1929 Curtis reported a case in which a satisfactory result followed an end-to-end anastomosis and stated "I believe that this is the only recorded case in which end-to-end anastomosis of the ureter has been followed by clinical proof of normal kidney-ureter function." To the successful proven cases we add Case 1 and as further proof of the well-known fact that the absence of symptoms following the repair of a ureter does not prove the result satisfactory, we cite Case 2 in which complete healing with occlusion occurred after the removal of an undraining



Fig. 7 Bilateral ureterograms (retrograde reversed). Catheters could not be passed to kidneys as one ureter was completely occluded and the other was nearly occluded at the point of injury. Case 5.

catheter which permitted free drainage from the kidney for 15 days after the operation.

CONCLUSIONS

1. Normal kidney-ureter function may be obtained following complete severance of a ureter by end-to-end anastomosis over a ureteral catheter.
2. Simple ligation of a severed ureter is contraindicated if the condition of the patient will permit a conservative operation.
3. The absence of symptoms following the repair of a severed ureter does not prove the result satisfactory.
4. In old injuries of the ureter a suitable procedure must be adopted to each case. Reimplantation into the bladder is desirable if possible. Implantation into the bowel, nephroureterostomy or nephrectomy may be indicated.

REFERENCES

- CURTIS, A. H. *Surg. Gynec. & Obst.* 1929, 48, 320-321.
 YODanis, H. H. *Practice of Urology*, Vol. 2.

THE PROGNOSIS OF THYROID CANCER

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IT is generally recognized by all students of thyroid cancer that considerable confusion exists because of a terminology which varies with each author and because of different interpretations of the histology. We believe that in the last analysis histological studies of thyroid cancer are of value only as they benefit the clinical management of thyroid cancer cases. Attempts to associate certain histological pictures with more or less precise clinical findings have been made by pathologists since the days of Virchow. Such studies have proved of definite value in the clinical management of cases of buccal malignancy, bladder malignancy, bone malignancy, and so forth. It is logical to apply these methods to a study of cancer in the thyroid and we believe that by this method very definite help is provided to the clinician.

It has long been apparent to clinicians that certain types of malignancy in the thyroid were relatively benign, slow growing, and more or less amenable to treatment. It has been equally apparent that other cases of thyroid malignancy were extremely rapid in their course and entirely uninfluenced by treatment. It is our experience that these clinical types are characterized in general, by very definite histological anatomy and that the clinical grades of thyroid malignancy fall readily and easily into corresponding histological classes.

Our studies of thyroid malignancy first correlated these findings in 1929 (2) but in 1931 (3) the present method of grouping thyroid malignancy both from the clinical and the histological findings was emphasized. Increasing experience in the method that we discussed in 1931 has demonstrated to us its distinct value. We have repeatedly been able to predict the histology of certain thyroid cancers from our clinical observation of the patient before operation and we have usually been correct in our clinical prognosis of thyroid patients once the histology of the cancer had been presented to us by the pathologist.

We divide thyroid cancer into three clinical groups. In group I we have the patient with low or potential malignancy. In group II we have the patient with definite but not hopeless malignancy, and in group III we have the patient with severe and usually incurable malignancy. Patients can be placed in these clinical groups on

the histology of their tumors. Only by this combined histological and clinical grouping can an adequate prognosis be given and a constant background for comparison of results be obtained.

MATERIAL FOR STUDY IN THIS PAPER

In this review there are included 226 cases of cancer of the thyroid in which we have histological sections for study. The great majority of these patients have been operated upon, but in a few of the cases only autopsy material is available. These 226 cases have been seen in the Lahey Clinic up to January 1, 1932. None of the cases occurring in the Clinic during 1932-1933 or 1934 has been included.

Up to January 1932 there have been 18 additional inoperable cases of cancer of the thyroid in the Clinic which are not included in this study. Since no tissue was available in these cases they could not be classified histologically. All 18 are now dead.

Many of these 226 cases of cancer of the thyroid have been previously studied and reported upon. Thus in 1929 Clute and Smith (2) reported 67 cases of malignancy seen in the Lahey Clinic and in 1931 we (3) made a further study of all thyroid malignancy in the Clinic including those previously reported. The present study includes the cases reported in these two previous papers and such new cases as have occurred in the Clinic up to January 1, 1932 (Chart 1).

A constant follow up of all cancers of the thyroid seen in the Clinic is maintained. In the group I cases, the least malignant type, only 6 were completely lost. In groups II and III no cases were lost. We have therefore, a 97 per cent follow up on the 226 cases of thyroid cancer reported in this paper.

The papers on thyroid malignancy by Wilson, Graham, Pemberton, Wegelin, and Haagensen have well summarized the older literature as well as presented important new facts. It is unnecessary to review again the literature on this subject which these writers have covered.

CENTRAL CONSIDERATION OF CANCER OF THE THYROID

Symptoms. The classical symptoms so called of cancer of the thyroid are really those of the end stages of thyroid malignancy. A rapidly growing goiter with irregular lobulation distort



Fig 1 Fetal adenoma with blood vessel in axon, malignant No 4858 X 50

ing the usual symmetrical shape of the thyroid gland is rarely present until the condition is hopeless. Hoarseness, stridor, choking, inability to swallow, all appear late in the disease as invasion of the larynx, laryngeal nerves, trachea and esophagus take place. While we must state these symptoms and recognize that they arise in the final stages of this disease, it is much more important to be familiar with the earliest findings suggestive of thyroid cancer.



Fig 2 Papillary cystadenoma, malignant No 067 X 5



Fig 3 Adenocarcinoma, papillary type No 576 X 5

In the early stages of thyroid malignancy just as in the earliest stages of cancer of the breast, there are no symptoms which are positive and diagnostic. The significant and suggestive findings, however, which point to the possibility of cancer in the thyroid are the slow growth of as



Fig 4 Adenocarcinoma, alveolar type No 3526 X 165



Fig 5 Squamous cell carcinoma No 6003 $\times 365$.



Fig 6 Carcinoma of Hurtle cell type No 21145 $\times 400$

adenoma over a period of weeks or months. Increasing firmness of the tumor and the occurrence of a sense of pressure in the neck with lack of freedom of its movement on palpation is also seen in relatively early stages.

Clinically we must differentiate thyroid tumors suspected of malignancy from cases of chronic thyroiditis of the Riedel's type and the Hashimoto type from cases of acute thyroiditis and from cases in which there has been a sudden hemorrhage into a benign adenoma.

Riedel's struma is perhaps as frequently mistaken for cancer of the thyroid as any thyroid swelling. Not infrequently the final differentiation of this tumor is made only by histological study of sections. In general, however Riedel's struma is diffusely and usually bilaterally of a stony hardness but the enlargement of the thyroid is symmetrical. There are as a rule, no nodules and the superior poles and inferior poles on each side can be felt to be much like those of a normal gland though enlarged. There is rarely fixation of the tissues in the neck in spite of the

hard thyroid tumor nor is there evidence of recurrent laryngeal paralysis. Local tenderness is often noted in Riedel's struma.

In Hashimoto's thyroiditis or struma lymphomatosa we have a rare type of firm thyroid enlargement which like Riedel's struma is apparently of an inflammatory nature but which is marked by a diffuse lymphoid infiltration of the thyroid and by a definite enlargement of the entire thyroid. Here also, there is no diffuse involvement of the tissues of the neck the enlargement maintains the usual contour of the thyroid gland but is firm and hard and very frequently is considered to be a case of chronic thyroiditis. Here the correct diagnosis is generally impossible until histological studies are made.

In acute thyroiditis the history is usually very suggestive of the type of lesion. In most cases a preceding respiratory tract infection has occurred. Within a few days or weeks a tender enlargement of one or both lobes of the thyroid gland appears. On palpation the thyroid is found to be symmetrically or unilaterally enlarged. The enlargement, however retains the general contour of the gland. There is very marked and definite



Fig 7 Carcinom simplex, compact type N 22977
X 70

local tenderness. Often there is a low fever and occasionally evidences of hyperthyroidism of mild degree are present.

Hæmorrhage into a thyroid adenoma may produce a most confusing picture. The history however in most cases gives the correct diagnosis. The patients may or may not have previously noted a goiter. Suddenly, as a rule following exertion the adenoma of the thyroid increases definitely in size. This swelling occurs in the matter of a few hours or a day and is associated with marked local tenderness and at times with symptoms of choking and pressure in the neck. The tumor following hæmorrhage, tends to subside slowly over a period of days or a few weeks. Such a history differentiates at once the firm hard swelling which is present on examination in these cases as due to a recent hæmorrhage and not to malignant degeneration. Malignant degeneration of an adenoma though it may be rapid, is never a condition developing within a matter of hours or 1 or 2 days.



Fig 8 Carcinoma simplex, diffuse type N 18914
X 225

Thyroid malignancy is suspected then, because of a firm hard discrete type of tumor in the thyroid gland because of recent growth, either slow or rapid and because of secondary evidences of pressure such as difficulty in swallowing and breathing and hoarseness. Thyroid malignancy soon leaves the normal contour of the thyroid gland to grow in an irregular and unrestrained manner and to become adherent to adjacent structures. In a few cases, the presence of enlarged lymph nodes near the goiter is suggestive of the presence of malignancy. In rare cases bone metastases may be the first indication of the presence of malignancy in an apparently benign adenoma.

Sex. In 226 cases here studied 198 were females and 28 males, an incidence of 7 females to 1 male. The incidence of thyroid disease is in general much greater in women than in men. During the past 5 years, 4,779 patients were operated upon for goiter. Of these 648 were men—an incidence of 7 females to 1 male for all thyroid disease. The similarity in these figures is impressive and may indicate the common origin of cancer in previously diseased thyroids.

Age. Cancer of the thyroid while appearing most commonly in middle life may nevertheless appear at any age (Chart 2). The youngest patient in the series was 9 years of age. Increasing experience with thyroid malignancy has demonstrated to us the great fallacy of thinking that youthfulness of the patient precludes the presence of cancer of the thyroid. Of our patients 8 were 20 years of age or less, and 2 of these have died of cancer 1 aged 9 and 1 aged 13. Furthermore it is to be noted from the chart that 39 of our patients (or 16 per cent) were less than 31 years of age and 77 or more than one-third of all our patients were less than 41 years of age.



Fig. 9 Giant cell carcinoma No. 11245 X365

The age distribution chart shows that there is a preponderance of group I thyroid tumors in the age of greatest sex activity the great majority of these patients being 20 to 50 years of age (Chart 3). No such marked association with the active reproductive period is noted in the more malignant tumors of group II or group III which in fact tend to be more common after middle life (Charts 4 and 5).

Previous goiter. It has been stated by different writers on cancer of the thyroid that an adenoma of the thyroid or an adenomatous goiter preceded the malignancy in 90 per cent or more of all cases of thyroid cancer. We have attempted to obtain accurate figures as to the presence of a pre-existing goiter in our group of cases. Such figures however are open to a certain amount of question because of fallacious observations by patients. In many cases, however the pathology of the gland establishes the presence of an antecedent adenoma. We may generalize from this series and say that a goiter was almost invariably present for an appreciable time before operation in the patients of groups I and II. In group III however we find that often no goiter was noted longer than a few weeks or months before operation.

Cancer may occur coincidentally with exophthalmic goiter. We have in our records 4 cases of exophthalmic goiter and coincident malignancy of the thyroid gland (1). In these cases it is our belief that the malignancy occurred in a coincident adenoma in the hyperplastic gland but that the hyperthyroidism was related only to the presence of hyperplasia in the otherwise normal thyroid tissue.

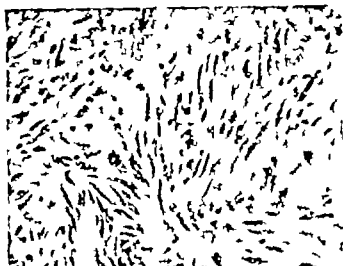


Fig. 10 Fibrosarcoma No. 18794 X225

We have no evidence that hyperthyroidism arises as a result of the activity of malignant thyroid tissue itself. There is however evidence that some thyroid malignancies have secretory power. The classical example of function is afforded by Eiselsberg who reported the development of hypothyroidism in a woman after complete excision of an adenomatous thyroid gland. With the development of a large nodule in the sternum the hypothyroid symptoms disappeared but on removal of the sternal nodule which proved to be a metastatic adenocarcinoma of the thyroid she again became hypothyroid. The presence of active principle in the tissue of struma ovarii has also been well established.

GROUP I. LOW OR POTENTIAL MALIGNANCY

Group I is divided pathologically into 2 classes (1) adenoma with blood vessel invasion and (2) malignant papillary adenocarcinoma. We place first the adenoma with evidence of blood vessel invasion (7). The adenoma is of usually undifferentiated type either embryonal consisting of simple stalks of thyroid cells without evidence of alveolar formation usually arranged in a loose oedematous stroma or fetal with numerous small follicles, often showing no colloid with some cords or stalks of undifferentiated epithelial cells (Fig. 1). The stroma in these is also frequently abundant and oedematous with thin walled vessels, so just what we can regard as significant blood vessel invasion is uncertain. In 114 adenomata examined by Warren 31 per cent showed varying degrees of invasion of blood vessels and 10 per cent of these died of metastases. Adenomata in which fully developed carcinoma is present are not included in this group, but are classified under the appropriate type of carcinoma.

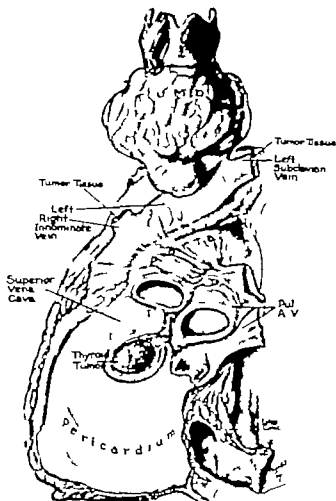


Fig. 11. Artist's drawing of autopsy specimen. Patient aged 60. Gouty 30 months—histologically adenocarcinoma of the thyroid with blood vessel invasion. Note the growth of tumor tissue through the subclavian and innominate veins into the superior vena cava. A similar case was previously reported in 1939 from this Clinic (Reference V.)

When grossly demonstrable invasion of vessels is present there is no question as to the malignancy of the tumor. In the group in which there is microscopic evidence of invasion only there is a 95 per cent chance that the tumor is not actually malignant. However the appearance of the 5 per cent which metastasize and kill and the 95 per cent which do not is identical. Thus the only safe course is to regard all relatively undifferentiated adenomata showing any evidence of blood vessel invasion as potentially malignant, and those showing gross evidence of blood vessel invasion as definitely malignant. Rarely in this type of tumor is it the metastasis, particularly the

metastasis to bone, that first calls attention to the existence of a thyroid adenoma with blood vessel invasion. We have never seen an adenoma metastasize or recur locally without evidence of blood vessel invasion.

It is important in searching for evidence of blood vessel invasion not to be misled by bits of thyroid tissue adventitiously caught in the vessels during the preparation of the sections. Definite evidence of invasion of the vessel wall and of intravascular proliferation is essential. Invasion of the capsule may or may not accompany vascular invasion. Haagensen, in his recent discussion of radiosensitivity of thyroid malignancy does

CASES OF CANCER OF THYROID TO JANUARY 1 1932

Histology and Group	Total No	Followed	Per cent Follow up	Dead cancer	Per cent Dead	With Recurrence	Dead or Recurrence	Per cent Dead or Recurrence	Dead other causes	Alive and well
Group I 66 per cent—Adenomas with blood vessel involvement	99	85	85	3	3	1	4	4	3	75
Papillary adenocystomas	51	50	98	4	7.8	2	6	11.9	8	50
Totals group I	150	135	90	7	5	3	10	7	1	114
Group II 23 per cent—Adenocarcinoma	31	31	100	17	54.8	4	1	26		10
Totals group II										
Group III 10 per cent—Fibrosarcoma	3	3	100	3	100		3			
Epidermoid carcinoma	1	1	100	1	100					
Giant cell cancer	1	11	100	9	8.8		9			2
Small cell cancer	30	30	100	23	76.5	3	26	86		4
Totals group III	45	45	100	36	80	3	39	86		6
Total cases Carcinoma of thyroid	76	11	93	60	78.9	14	70	92.1		

* 3 "lost" cases with 3 yrs. and over

† "lost" case with 60 3 yrs

Chart 1. Tabulation of cases in this study showing division into three groups and the relative mortality of these groups

not speak of this type of tumor as a separate entity

We regard papillary adenocystomata as malignant if they show evidence of capsule blood vessel or lymph vessel involvement. Inasmuch as the excellent study by Montz carefully distinguishes the various recognized types of papillary tumors of the thyroid, we will not attempt to summarize the various forms of tumors of papillary type which may be encountered but will describe here only that type included in this particular group

The tumor is cystic, grossly capsulated, sometimes with gross evidence of ingrowth into veins. Origin from aberrant thyroid tissue is not infrequent. At times the origin of the tumor may be multiple although it is very difficult to distinguish between multiple origin and lymph node metastases. On section contents of the cyst are usually fairly scanty, sometimes serous, and more often blood tinged. Rarely, evidence of calcification is present in some of the papillae. Under the microscope we see usually a fairly dense fibrous capsule often invaded in one or more places by ingrowth of tumor tissue, and a tracery of branching papillae usually with a fairly obvious stromal cord carrying an abundant blood supply and lined with a single layer of epithelium ranging from cuboidal to high columnar (Fig 2). Nuclei are not placed uniformly toward the base of cell

as in the case of the more delicate papillary projections seen in the follicles in thyroid hyperplasia, but they may occur in almost any position in the cell, often occupying the center. Mitotic figures vary in their frequency although usually on prolonged search some can be found. These however, are of but little avail as distinguishing the lesion from the epithelial changes of hyperplasia inasmuch as here also mitotic figures may be encountered in the epithelium. We regard invasion of the capsule, invasion of the blood vessels or of lymph channels as being requisite for the determination of malignancy in this type of tumor

The marked radiosensitivity of this type of tumor is to be expected because of its papillary character. This is a feature usually associated with a good response to radiation in whatever organ the tumor may arise.

The clinical history of the group I patients is at times suggestive of the lesion which is found on histological examination. A goiter had been present in certainly 90 per cent of these patients for months or years before they came to operation, and as a rule the adenoma had shown no rapid change in size. The patients, however, not infrequently state that it had slowly become larger over a period of months or years. This growth should arouse the suspicion of possible malignant degeneration

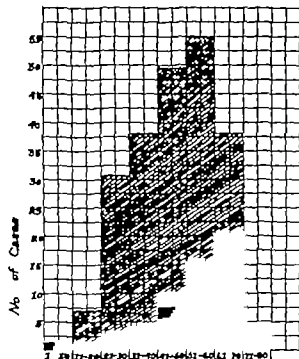


Chart 2. Age distribution of cancers of the thyroid with fatalities of each age decade

On examination the majority of patients show a discrete adenoma of the thyroid which is often slightly firm but usually is freely movable. Occasionally the adenoma feels quite hard and this strongly suggests malignant degeneration. In a few cases the process has advanced to such a degree that the tumor is large and firm and hard, diffusely attached to the overlying tissues and obviously malignant. This finding however is a very unusual one among those cases which are classified under group I.

On clinical examination it is occasionally possible to decide whether the tumor is an adenoma with blood vessel invasion or a papillary adenocystoma. If several nodules are felt along the course of the jugular above the tumor they suggest very strongly that a papillary adenocystoma is to be suspected.

Of the 99 patients having adenoma with blood vessel invasion, 85 are followed to date. 8 others were followed for over 3 years before they were lost, and 6 could not be traced. Three patients in the 99 are known to have died of cancer of the thyroid, and 1 patient is still alive with a large recurrence present in the neck. Three others have died of causes unrelated to their goiter. Of the 99 patients 86 are well and free from cancer of the thyroid.

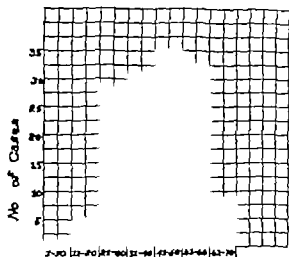


Chart 3. Age incidence of group I cases of thyroid cancer. Note the large numbers in this group occurring in early adult life.

Of the patients having adenoma with blood vessel invasion 89 were females and 10 were males. The age distribution for the cases with adenoma with blood vessel invasion follows closely the age distribution for all the cases in group I as shown in the chart.

The cause of death in 3 patients with adenoma with blood vessel invasion in each instance was local recurrence of the growth with metastases into the mediastinum and into the lungs. In 2 patients death occurred 5 years after the operation, and in the third patient within 1 year. In all 3 patients, however, it was evident for over 3 years that cancer of the thyroid with extensive invasion was present before death occurred.

Of the 51 patients with papillary adenocystoma, all save 1 were followed to date, and the 1 patient when lost was known to have been well 3 years after operation. Of these 51 patients, 36 are well with no evidence of malignancy and 8 have died of non-related causes. Four patients have died with local recurrences of whom 1 also had a metastasis in the brain. Two other patients in the group have large recurrences present now in the neck which are apparently quiescent under X-ray treatment.

Nine of the papillary adenocystoma patients were males and 42 were females—about 1:5. The age distribution follows that of the group there having been 1 case (fatal) in a boy of 9 and 6 cases in the sixth decade.

The deaths and recurrences in the papillary adenocystoma cases resemble in their clinical history very much the deaths occurring in patients

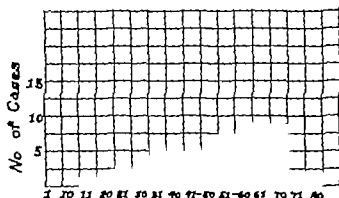


Chart 4. Age incidence of group II cases which tend to be increasingly common in middle age

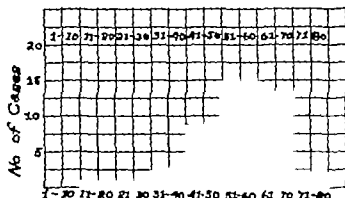


Chart 5. Age incidence of group III cases which like group II occur most frequently at middle and old age.

having adenoma with blood vessel invasion. There were 4 deaths in the patients with papillary adenocystoma from cancer of the thyroid. All of these patients showed local recurrence with slow extension into the surrounding tissue. Two of these patients were inoperable when first seen yet following biopsy and X ray treatment lived 3 years and the other 1 year.

Two of the patients in the group have definite recurrences in the neck with extension into the mediastinum and into regional lymph nodes, one of which has been present, although held quiescent with X ray for 3 years, and the other for 4 years. One of the patients with the persistent recurrence was inoperable at the first operation and only a biopsy was done. Following a year of X ray treatment however it was possible to remove a large proportion of the tumor and 4 years after this, he was still well though nodules were present in his neck.

Our follow up studies, then of these 150 patients of group I type are complete for 135 or 90 per cent. Nine were lost after having been followed and found well for 3 years. Of the 144 cases 7 or 5 per cent, had died as a result of cancer of the thyroid and 3 others had definite recurrences. This means that 10, or 7 per cent, of the 144 patients followed in group I were dead or had recurrences from cancer of the thyroid. In our previous study in 1931 the mortality of group I cases was 4.5 per cent and it is gratifying to note that as several more years have passed in this group of patients, on further follow up, there is no tendency to increase the mortality from thyroid cancer recurrence. All recurrences or metastases in this group have occurred within a year after operation.

While a great many of the patients in group I have had X ray treatment as a routine for the first year following their operation, there have, nevertheless been many other patients who have

had no X ray treatment. It is not apparent to us, therefore, that failure to have recurrence following the removal of the group I type of cancer is due to the use of X ray treatment. There is no doubt, however that tumors in group I are quite susceptible to X ray treatment since we have in several cases seen inoperable tumors shrink to such proportion that their radical removal was possible after X ray treatment. It is also our experience with the recurrent cases that extension of the growth has been markedly slowed and limited by persistent X ray treatment after operation.

In all group I patients, recurrence tends to take place along the veins of the neck following the course of the blood stream toward the heart. Nodules therefore, appear in the mediastinum and in the lung. Local extension by penetration of the capsule by the growth also appears as a rule within a few months after operation if recurrence is to appear. Metastasis of the papillary adenocystoma frequently occurs by the lymphatic stream with involvement of the regional lymph nodes.

For the group I patients then, we may state first, that all of the patients dying from cancer of the thyroid of the group I type have been patients with clinically obvious cancer of the thyroid which was far advanced at the time of the original operation, and had been present for months or years before operation. All of the patients with local recurrences had extensive growths at their first operation and recurrences were apparent within a year after operation. Only the clinical findings indicate the prognosis in these cases since the histology is alike in all. Finally, in none of the patients that we have followed in this group has any recurrence appeared when the patient was well to clinical and X ray examination a year or more after the original removal of the thyroid tumor.

GROUP II ADENOCARCINOMA OF THE THYROID

In group II we place all cases of adenocarcinoma of the thyroid. Here although the lesion is unquestionably malignant there is some hope of cure and much chance of long relief and palliation by active treatment. In these tumors the usually accepted criteria of malignancy and plasma and invasion of surrounding tissue are obvious, but the degree of preservation of glandular structure varies considerably. In all of the tumors of this group however we expect to find some evidence of glandular structure and alveolar formation. Histologically the group may be readily divided into two forms, the papillary adenocarcinoma and the non papillary or alveolar.

The papillary form of adenocarcinoma differs from the malignant papillary cystadenoma of group I, by having more than one layer of epithelium over many of the papillary projections (Fig 3). There is a greater variation of size and shape in the epithelial cells and a definitely greater extent of invasion, not only of the capsule which is often indistinct or non-existent, but of the surrounding thyroid tissue and muscle as well. Mitotic figures are usually fairly frequent in the cells and tumor giant cells are occasionally encountered. In this type of cancer distant metastasis is rarely seen but regional lymph nodes are frequently involved whether by direct extension or by lymphatic metastasis is uncertain.

The alveolar type of adenocarcinoma, as has been brought out by Haagensen and others, presents a fairly wide variety of histological types. These range from forms resembling the more anaplastic of the adenomata (corresponding to the *wuchernde Struma* of Langhans) with predominant alveolar arrangement and not infrequent colloid-containing follicles, to tumors made up of cells barely recognizable as of thyroid origin with, however some maintenance of alveolar structure (Fig 4). Even in the less differentiated forms, however we can distinguish them from adenomata with blood vessel invasion by the slight or absent evidence of encapsulation, by the free invasion of surrounding structures, whether thyroid itself or muscle and by a distinct degree of anaplasia of the cells, many of which are small hyperchromatic, and ill-defined. In practically all the carcinomata of this group evidence of either blood vessel or lymphatic invasion can be found, if search is made. So far as we can judge from illustrations some of the tumors included in the *wuchernde Struma* we place in the group of adenoma with blood vessel invasion rather than in the group at present under discussion.

One special, though rarely occurring, variety of the adenocarcinoma is the so called Hurthle cell carcinoma (Fig 6). We have had but one clear cut example of this type although portions of some of our other adenocarcinomata have shown large clear acidophilic cells of the sort considered to be characteristic. The similarity between these cells and certain of the changes in thyroid cells most frequently encountered in involutions following primary hyperplasia led us to follow Ewing and others in considering this tumor as a true thyroid carcinoma rather than as of parathyroid origin as suggested by Eisenberg and others. While admittedly the cells resemble the oxyphil cells of the parathyroid, they appear to us to resemble even more closely the acidophilic phase occasionally encountered in the thyroid epithelium itself.

Because of the diverse character of this group it is rather difficult to lay down any general statement as to its probable behavior in regard to metastasis. Undoubtedly it would be desirable to separate the extremes of the group but when the adenocarcinomata are assembled they grade so imperceptibly from one to another that any establishment of a dividing line would be purely arbitrary.

CLINICAL COURSE OF GROUP II CASES

The typical clinical findings in the group II patients are in many respects similar to those present in the group I cases with the exception that the course of the disease is more obviously rapid, more definitely malignant, and more clearly serious.

The usual history of the patient with adenocarcinoma of the thyroid is that a goiter has been present for many years but within a short time perhaps 6 to 8 weeks, definite and obvious growth of the tumor has occurred. The patient frequently notes pressure symptoms as the tumor enlarges. These may be choking attacks or simple sensations of fullness in the neck. Hoarseness may occur early in these cases if the tumor lies near the recurrent laryngeal nerve.

On examination the usual finding is a discrete adenoma of the thyroid which is hard and firm and may be fixed to the surrounding tissue. It gives the examining finger the definite sensation of malignant tissue localized in a small area. In the more unusual cases the lesion is frankly an extensive malignancy obviously inoperable with wide involvement of all the tissue in the neck.

Three of the patients of group II were males and 28 were females—19. Adenocarcinoma is most commonly a disease of middle and late

life as is seen from the chart. It is important to note, however, that examples of this type of tumor may be seen in youth.

In the group II cases there were 31 patients all of whom have been followed to date. Seventeen have died of cancer of the thyroid while 4 others show definite evidence of recurrence. In other words, 54.8 per cent of the patients in this group have died of cancer of the thyroid and 68 per cent have died or have a recurrence of the disease. Ten are alive and well with no evidence of trouble.

In 9 or over half of the 17 fatal cases in group II minor operations such as biopsies alone or tracheotomies or decompressions of the prethyroid muscles were done at the time of operation and death occurred within days or weeks of this procedure. In 3 of the 8 remaining cases, radical removal of the obviously malignant tumor was followed by rapid recurrence and death. In 5 of the patients, however, radical operation plus X ray treatment seemed definitely to delay the fatal results death not occurring until some 2 to 5 years later.

Recurrences in these fatal cases were noted most commonly along the jugular vein and in the superior mediastinum (Fig 11). Metastases to the lungs were frequent. In 1 patient metastasis was apparently found in the pancreas at an abdominal operation 2 years after the removal of the adenocarcinoma from the thyroid. At this time no evidence of local recurrence was noted but sections from the pancreas were consistent with adenocarcinoma of the thyroid.

Four of the patients in group II are still alive with definite recurrences of their malignancy. In all 4 examination of the neck shows large hard firm, fixed masses extending downward into the superior mediastinum. In 2 of these patients X rays of the chest show definite metastatic nodules present in the lungs. All of these patients have had intensive X ray treatment, and their recurrences have been known to be present for 6 years, 5 years, 4 years and 3 years, respectively. In 3 other patients, recurrent nodules which had become localized and more or less discrete following long X ray treatment have been removed at second operations. In all of these patients however further recurrences have been noted following this secondary removal.

The 10 patients who are well have gone from 3 to 9 years with no evidence of difficulty.

When we reported on cancer of the thyroid in 1931 we found that the mortality in group II for the adenocarcinoma cases was 23.9 per cent. With longer follow up of these same patients and others of this group however we note that the

mortality now is more than double 54.8 per cent. It seems very clear that adenocarcinoma of the thyroid is a relatively slowly growing tumor nevertheless a most serious one since recurrences and deaths from cancer occur years after an apparently successful removal of the growth.

It is apparent that X ray treatment has a very salutary effect upon these adenocarcinomata and we believe that it has added to the longevity of patients who had obvious recurrences of the tumor. Furthermore, in other cases, inoperable tumors have become operable after intensive X ray treatment. It is not apparent, however, that the further removal of these collections of malignant tissue that have become more discrete following X ray treatment has been followed by any cure of the disease. As time goes on in these patients brawny induration and thickening of the neck with deeply placed malignant nodules have always been present. Haagensen reports a 71 per cent primary regression with radiation in cases of group II and a mortality of 57 per cent.

GROUP III HOPELESS MALIGNANCY

We include in group III the most highly malignant tumors. These we have subdivided into 4 classes the squamous cell or epidermoid carcinoma the carcinoma simplex or small cell carcinoma with evidence of alveolar formation which may be either compact or diffuse the giant cell carcinoma, often called carcinosarcoma or giant cell sarcoma and the fibrosarcoma, which is extremely rare. We do not include in the group the lymphosarcomata. We have yet to see a lymphosarcoma giving clear cut evidence of primary origin within the thyroid in spite of the frequency with which lymphoid infiltration of this organ is seen. In general we believe most of the so called primary lymphosarcomata of the thyroid to be small cell carcinomata of the diffuse type. All the tumors of group III are characterized by marked anaplasia by frequent invasiveness by a considerable degree of mitotic activity and by relatively free metastasis.

Although the clinical course of the group III cases is decidedly uniform, the pathological anatomy is varied. In the class of the squamous or epidermoid type of carcinoma, our only case gave evidence of origin from the thyroid stalk and may represent development from an embryonic rest or possibly from metaplasia of persisting thyroglossal duct epithelium. The presence of definitely keratinized cell membrane intercellular bridges and frequent formation of epithelial pearls leaves no question as to the nature of this tumor (Fig 5).

The second type of tumor in group III the small cell carcinoma or the carcinoma simplex, shows no evidence of alveolar formation, thus distinguishing it from tumors of group II. The type cell is often small polyhedral, and ill defined varying markedly in its relation to adjacent tumor cells and to the stroma (Fig. 7). Usually it has a large hyperchromatic, although occasionally vesicular nucleus. Mitotic figures vary a great deal, sometimes being very frequent and other times rather rare. Invasion of the surrounding tissues is always marked and blood vascular or lymphatic invasion practically always demonstrable. In the compact type of small cell cancer the epithelial cell masses occur in large or small clusters, closely approximated with one another with intervening bands of stroma. This structure is usually maintained in the metastases. In the diffuse type (Fig. 8) similar cells are scattered through the stroma either occurring singly or in clusters of 2, 3, or 4, as seen in the section. The cytoplasm is indistinct and ill defined, the nucleus prominent and hyperchromatic. Often the nucleus is practically all of the cell that can be seen. This coupled with the irregular scattering of the cells through the tissues, is undoubtedly strongly suggestive of lymphoblastoma. However we feel the nucleus to be distinctly of epithelial type and the tendency to clumping of the cells in some areas to be suggestive of carcinoma rather than lymphoblastoma. Metastases of this type of tumor are widespread and rarely have we seen a very definite epithelial type of growth in the metastases. As further aid in differentiating these tumors from lymphosarcoma the response to radiation is of value. In marked contrast to the radiosensitivity of tumors of the lymphoblastic series, this particular type of thyroid carcinoma is, in our experience, absolutely radio-resistant. Moreover in the lymph node metastases the epithelial character of the cells, and the manner of growth clearly distinguish the lesion from lymphoblastoma.

As to the specificity of type of the giant cell carcinoma of the thyroid there is no question. Here again, however there is dispute as to the exact nature of the tumor cells. We regard them as epithelial. This point was clearly demonstrated recently by Smith. This tumor often presents one of the most bizarre pictures encountered in oncology. Almost every conceivable size and shape of cells with marked variation of nuclear structure are seen (Fig. 9). Mitoses are frequently present and often are atypical to a startling degree. There is a strong tendency for rather plump spindle cells to predominate, although at

times polyhedral cells grouped compactly or even in pseudo-alveolar form surrounded by stromal bands are the outstanding feature of the growth. We have not succeeded in demonstrating fibroglia fibrils in relation to any of the spindle cells of this group.

In the last type, the fibrosarcoma, we have three examples. These are apparently perfectly typical fibrosarcomata. Their cells form both fibroglia fibrils and collagen and tend to be fairly uniform, elongated spindle cells arranged in strands, with an elongated nucleus of a somewhat vesicular type (Fig. 10). The character of the cells is fairly uniform throughout the tumor and only by its definite origin in the thyroid could it be differentiated from a typical fibrosarcoma of soft parts.

CLINICAL COURSE OF GROUP III CASES

The typical history in a group III cancer of the thyroid is often sufficient to give a definite suggestion of the type of lesion which is present. In most instances a goiter suddenly appears in middle or late life and rapidly increases in size. In some cases, a goiter has been present before attention was attracted to it by its rapid growth, but this is unusual.

Accompanying the growth of the tumor in the neck are pressure symptoms. These vary from a feeling of discomfort over the swelling with a sensation of pressure on swallowing to actual choking and dyspnea.

The rapidity with which group III tumors increase in size is often amazing. In many instances a tumor 10 centimeters in diameter is present a few weeks after the first small swelling appeared. This finding is especially common in the giant cell cancers.

On clinical examination the findings which the history suggests of a rapidly growing malignant tumor are usually confirmed. The mass is asymmetrically placed and it is firmly and widely attached to the thyroid gland. One readily gains the impression that the tumor has involved the whole lobe of the thyroid and is not just attached to it or growing in it. Very often the tumor is adherent to the structures overlying the thyroid gland and therefore, can be but slightly moved. Glands may at times be felt along the jugular vein and chest X rays may show metastases in the lungs at an early stage in the disease.

As will be seen from the chart, these patients are most frequently at middle life and beyond, regardless of the subtype of group III to which they may belong. All of the patients having small cell cancers were at middle life or over save

one boy of 13 and a woman of 25. All save two of the patients with giant cell cancer were 60 or more years of age and these two were 36 and 54 years, respectively. In the 45 patients in group III only 6 were males and curiously enough 5 of these 6 had small cell cancers while the other one had an epidermoid cancer. All the 11 giant cell cancers occurred in women.

There were 45 patients or 19 per cent of this series of 226 cancers of the thyroid who fall into our group III both by their histology and by their clinical behavior. All of these 45 patients were followed to date. Thirty six, or 80 per cent, have died of cancer of the thyroid. Three other patients now have serious recurrences so that 39, or 86 per cent of the group III cases are either dead or dying of cancer of the thyroid. In 1931, we reported the mortality of this group as 82 per cent. It would seem therefore that the same serious outlook prevails for these tumors with the treatment we have used.

It had been our plan up to January 1, 1934, to do as radical an operation as was possible in each of these cases and to follow this with X-ray treatment. Radium therapy has not been used in these cases up to January 1, 1934 but since that date we have added the use of radium to the operation and X-ray treatment. It is our plan to follow the results of this additional therapy closely and to report upon it at some future time.

In general X-ray therapy has been very disappointing in the group III cases. In most instances it has not affected the rapidity of the growth of the malignant tumor in spite of the relatively undifferentiated type of cells involved. In only 2 or 3 instances has it been apparent to us that X-ray treatment has checked or controlled the rate of growth. In only 1 case has an inoperable mass been reduced appreciably in size by X-ray treatment.

In 21 or nearly half of the cases in group III only palliative operative measures could be done. These consisted of biopsy only or biopsy plus decompression of the pretracheal muscles or tracheotomy. The very low operability of the group III cases is further evidence of the serious nature of the malignancy since many of them were seen within 2 months of the onset of the tumor.

The recurrences and metastases in the group III cases are seen early in the postoperative course. Local recurrence almost always is present and this tends to spread widely through the neck and into the mediastinum. In 1 patient, the growth spread in a few weeks from the neck into the right axilla. In another patient there was no evidence of any trouble for 4 years after operation

when multiple metastases appeared in the spine. In another case of small cell thyroid cancer retroperitoneal metastases occurred 4 years after the thyroid operation. Late metastases, however, are not common in group III cases. In most instances recurrences and metastases appear within a few weeks after operation and the course is rapidly fatal.

More than half of the deaths in the small round cell cancer cases occurred within 9 months of operation. There were, however, unexpected examples of longevity in some since 3 patients lived 3 years before dying of cancer and 6 lived over 1 year. Furthermore in 2 patients no recurrence appeared until 5 and 6 years after operation. Rapidity of growth and recurrence was especially notable in the giant cell cancers where the average length of life after operation in the 9 fatal cases was 4 months and the longest period 8 months. Similar rapidity of fatal endings occurred in the 3 fibrosarcomata and the 1 epidermoid cancer case.

The prognosis for the group as a whole appears to be hopeless with the therapy we have used. The few patients who in our previous studies appeared to be progressing favorably have developed late metastases and died. Of the 6 patients alive and well 2 had giant cell cancers 2 and 5 years ago. Four had small cell cancers and have lived 2, 4, 5, 10 years, respectively, since operation. This low survival rate graphically shows the serious prognosis of group III thyroid cancers and we believe that it is this particular group of cases that has given cancer of the thyroid its more or less justly deserved bad name.

SUMMARY AND CONCLUSIONS

1. Cases of thyroid cancer in their clinical course fall readily into one of three groups: group I, with low or potential malignancy; group II, with definite but not hopeless malignancy; and group III, with severe and usually incurable malignancy. Clear cut histological findings also mark out these clinical groups.

2. By this combined clinical and histological grouping of thyroid cancer an adequate method is at hand for estimating the prognosis in any case.

3. This paper reports the results in 226 cancers of the thyroid seen in the Lahey Clinic up to January 1, 1937. All but 6 have been followed.

4. The symptoms and diagnostic features of cancer of the thyroid in general are reviewed.

5. Group I cancers of the thyroid are those of low or potential malignancy. Histologically these patients have either adenoma with blood vessel invasion or papillary cystadenoma with blood

vessel or capsule invasion. Seven per cent of these patients are dead of thyroid cancer or have a recurrence. No death or recurrence has occurred in this group in any case free of trouble for a year after operation.

6. Group II cancers of the thyroid have clear cut, definite malignancy for which there is some hope of cure and much chance of long relief. Histologically all are adenocarcinomata of the thyroid. The mortality of the group however is 55 per cent, many fatalities having occurred from cancer years after the original operation.

7. Group III cancers are clinically the most hopeless type. Histologically this group contains the squamous cell cancers, the small cell cancers, the giant cell cancers and the fibrosarcomata. All these tumors are of rapid growth, occur most frequently in middle and later life and usually are rapidly fatal. The mortality of the group III cases is 80 per cent and most of the deaths in this group occur within a few months of the operation.

8. The treatment used in this series of 226 cases has been operation and X-ray radiation. Group I cases are highly sensitive to X-ray radiation. Group II tumors may regress consider-

ably under X-ray which in many cases may prolong life for years. Group III tumors show almost no improvement with X-ray radiation. Since January 1934, we have supplemented surgery and X-ray radiation with radium therapy in certain cases. This added measure of treatment will be the subject of a later report.

REFERENCES

1. CLUTE, H. M. *Surg. Clin. N. America*, 1933, 13, 759.
2. CLUTE, H. M. and SMITH, L. W. *Arch. Surg.* 1939, 18, 1.
3. CLUTE, H. M. and WARREN, S. *Am. J. Cancer* 1931, 15, 2563.
4. EISENBERG, A. von. *Arch. f. Klin. Chir.* 1894, 45, 459.
5. EISENBERG, A. E. and WALLINGSTEIN, H. *Arch. f. Path.* 1932, 13, 716.
6. EWING, J. *Neoplastic Diseases*, 3d ed. p. 932. Philadelphia, 1928.
7. GRAHAM, A. *Surg. Gynec. & Obst.*, 1924, 39, 781.
8. HAAGENVELD, C. D. *Am. J. Cancer* 1931, 15, 2063.
9. MORITZ, A. R. and BOTLICK, F. *Am. J. Path.* 1931, 7, 675.
10. PEMBERTON, J. de J. *Ann. Surg.* 1928, 87, 369.
11. SATON, L. W. *Arch. f. Path.* 1930, 40, 524.
12. WARREN, S. *Arch. f. Path.* 1931, 11, 255.
13. WICKELIX, C. *Cancer Rev.* 1928, 3, 207.
14. WILSON, L. B. *Ann. Surg.* 1931, 74, 129.

AN ASEPTIC URETERO-ENTEROSTOMY¹

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Fellow in Medicine of the National Research Council

ALTHOUGH the Coffey-Mayo technique for the implantation of ureters into the bowel is frequently productive of good results clinically, it is fraught with the ever present danger of infection. The success of this procedure depends upon establishing a check valve in the distal course of the ureter. This is accomplished by imbedding the ureter between the muscularis and submucosa of the bowel for several centimeters just proximal to its ultimate opening into the colon through the submucosa and mucosa. By applying the principle of the check valve, Coffey succeeded in eliminating dilatation of the urinary tract by the intermittently elevated intraintestinal pressure.

To insure a properly functioning check valve, however, healing in the absence of infection must occur between the implanted segment of the ureter and the bowel. Only under such circumstances will a minimum of fibrosis and deposition of scar tissue result. A stiff indurated, non-flexible, intramural channel cannot be readily compressed by an increase of intraintestinal pressure and will not result in a correctly functioning check valve. Therefore, every permissible safeguard must be employed to prevent infection and secure perfect healing.

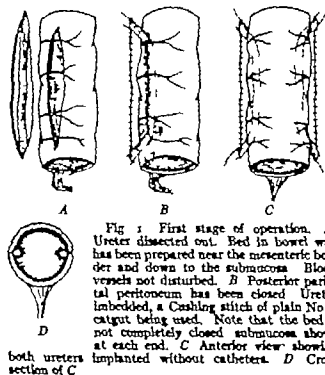


Fig. 1. First stage of operation. A, Ureter dissected out. Bed in bowel wall has been prepared near the mesenteric border and down to the submucosa. Blood vessels not disturbed. B, Posterior parietal peritoneum has been closed. Ureter imbedded, a Cushing stitch of plain No. 0 catgut being used. Note that the bed is not completely closed; submucosa shows at each end. C, Anterior view showing both ureters implanted without catheters. D, Cross section of C.

The operative technique for performing uretero-enterostomy to be described fulfills the following requirements: (1) complete surgical asepsis, (2) healing in a clean anastomotic bed, and (3) assurance of an opening between the ureter and bowel.

OPERATIVE TECHNIQUE

The operation is divided into two stages. The first stage is concerned with imbedding the intact and uninterrupted ureters in the wall of the bowel between the muscular layers and the submucosa. At the second stage the ureters are interrupted distally, openings are made between the ureters and the bowel, and the bladder is removed.

First stage of the operation. The first stage is readily followed in Figure 1. The ureters are dissected free for some 10 centimeters and the posterior parietal peritoneum is closed. The beds to receive the ureters are prepared in the same segment of bowel. Two incisions about 6 centimeters long extending longitudinally along the bowel approximately $1\frac{1}{2}$ centimeters on either side of the mesenteric attachment, are made through the serosa and longitudinal muscle fibers. The cut edges are separated by blunt dissection by means of the handle of the scalpel. Any remaining circular fibers are carefully divided without injury to the underlying vessels and submucosa. It is not necessary to place both implants in the same segment of the bowel, but since no damage is done to the blood vessels there is no contra-indication to doing so. In this experi-

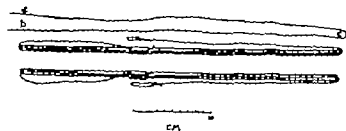


Fig. 2. Glass shields and cutting element. The glass tubes are threaded with silk sutures having loops tied in the free ends. The loop will be hooked over the end of the cutting wire to facilitate hauling it through the glass shield. a and b, Stiff blunt drawing needles. c, is a length of "advance resistance" wire, No. 24 B & S gauge.

The "advance resistance" wire is a nickel-copper alloy wire manufactured by the Draper-Harris Co., Montclair, New Jersey. This wire is well adapted to the procedure mentioned because it is flexible, has sufficient tensile strength when hot, and does not become brittle after heating. The electric current is adjusted to give a low red heat, which is satisfactory cutting temperature.

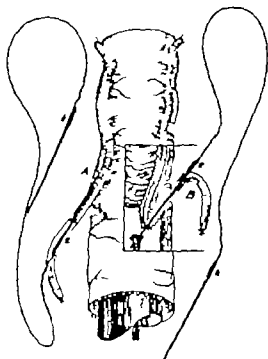


Figure 3. Second stage of operation. Bladder removed. Proctoscope inserted. Needle *a* has been inserted into the ureter and up to a point determining the proximal end of the opening between the bowel and the urinary tract. *B* Shows needle *a* having been thrust through the visceral wall and grasped by an alligator clamp in the proctoscope from below.

mental work on dogs, all implants have been made at the same level without any evidence of circulatory embarrassment. A single continuous Cushing suture of plain No. 0 catgut is used to imbed the ureter, the sutures passing into the submucosa. Sufficient tissue is included in the suture to approximate about 3 millimeters of serosa on each side. It is important to leave submucosa of the bowel showing at each end of the bed for a distance of approximately $\frac{1}{4}$ centimeter (Fig. 1*B*). This prevents sharp kinking and compression of the ureters. Urine flows freely within 3 to 4 days and ureteral catheterization is unnecessary. No attempt is made to extraperitonealize the ureters distal to the implant. Omentum is placed over the implants without suturing, and the abdomen is closed.

Second stage of the operation. After 3 weeks the abdomen is reopened. The ureters distal to the unbedded segments are isolated, clamped, and divided at a convenient distance beyond their exit from the bowel wall. The bladder is removed, and the bladder neck cauterized with phenol and closed. At this point a proctoscope is introduced

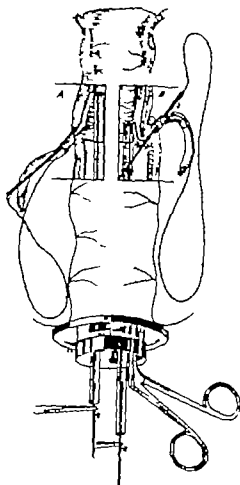


Fig. 4. Second stage of operation. *A*, Half the length of the wire has been pulled through, a shield of glass tubing has been placed over the wire, and needle *a* has been clamped to prevent slipping. Needle *b* is inserted into the ureter with its point just inside the distal junction of ureter and bowel. *B*, Needle *b* has been thrust through the visceral wall and grasped in an alligator clamp.

into the rectum and inserted until the end is opposite the distal junction of the imbedded ureter with the bowel wall (Fig. 3). An opening is made into the lumen of the distal segment of ureter about 2 centimeters from its exit from the bowel wall, and needle *a* of the cutting element, illustrated in Figure 2, is inserted up to the level at which the opening between ureter and bowel is to be made (Fig. 3*A*). With the edge of the proctoscope acting as a fulcrum the needle is rotated forward so as to invert the bowel wall, buried ureter and needle into the open end of the proctoscope. This accomplishment is evident to the operator from the abdominal cavity and it is plainly visible from below through the procto-

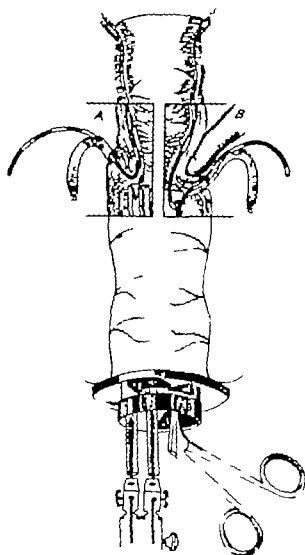


FIG 5

Fig 5 Second stage of operation A Shows entire cutting element in place with glass shields over both legs of the wire, the cautery handle attached and the protecting

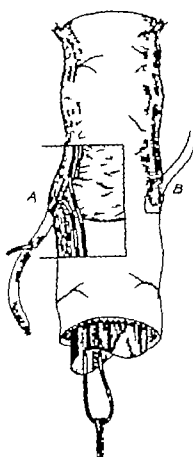


FIG 6

into the proctoscope when it is grasped with a clamp
Fig 6 Second stage of operation. A Shows the catheter being withdrawn through the proctoscope to obviate soiling of the abdominal field B The distal segment of ureter has been divided against the bowel wall, the small blood vessel coursing along the ureter has been tied, and a fine suture has been placed to invert the raw area in the bowel wall

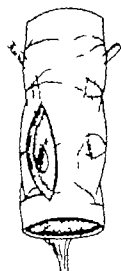


FIG 7

catheter inserted into the ureter Note that the electric cord to the proctoscope light must be disconnected before the handle of the cautery is attached! B The opening has been made and the cutting element removed. By digital pressure on the wall of the bowel and distal end of the catheter the latter is forced

Fig 7 Operation completed A section has been removed to show more clearly the opening into the bowel.

scope. Needle a is now thrust through the visceral walls grasped with an alligator clamp in the proctoscope from below and drawn out until half the length of resistance wire is pulled through. One of the shields of glass tubing is slipped over the wire as illustrated in Figure 4. Needle b on the other end of the cutting wire is put into the ureter and pushed through the visceral walls just inside the distal junction of ureter and bowel (Fig 4A and B). This needle is picked up and drawn out of the end of the proctoscope. At this point care must be taken to avoid crossing the legs of the resistance wire which would result in an electric short circuit later. A shield of glass tubing is placed over this leg of the wire and, after the electrical cord to the proctoscope light has been disconnected both needles are attached to the cautery (Fig 5 1). The ureter is catheterized

as indicated. By this procedure urine will not pass over the hot wire and the urethral wall and bowel opposite to the cutting element will be protected by the interposed catheter. Gentle traction on the handle of the cautery pulls the visceral walls into the open end of the proctoscope (Fig 5A). The circuit is closed and the cauterization is completed in about 15 seconds, where upon the cutting instrument can be drawn from the proctoscope. The wire should be examined to determine that it is intact. Should it have broken a second cutting element can be introduced and the entire procedure repeated. However ordinary care will make this unnecessary.

The bowel wall overlying the opening is inverted into the proctoscope with digital pressure and the distal portion of the ureteral catheter is pushed in to project into the proctoscope as a

loop (Fig. 5B). The length of the cauterized opening is clearly visible from below. The catheter is removed through the proctoscope to obviate soiling of the operative field (Figs. 5B and 6A). The distal segment of ureter is divided closely against the bowel wall, the ureteral vessel ligated and the raw area covered by a single suture in the wall of the colon (Fig. 6B).

Immediately following the completion of this procedure on the one side it is repeated on the opposite ureter. There is practically no bleeding, and urine is seen to flow freely into the proctoscope.

RESULTS

Following the first stage, in which both ureters are imbedded simultaneously the blood urea is usually increased for 3 or 4 days corresponding to a temporary postoperative anuria. The animals drink and eat very little during this time. They then begin to drink and urinate freely and the blood urea returns to normal in the course of the next 2 days. Some of the animals eat, drink and urinate normally the day following operation and the blood urea is not increased during this postoperative period. None of the animals show any gross abnormalities. Intravenous urography reveals no dilatation of ureters or kidney pelvis. When the second stage of the operation is done some 3 weeks later there is no evidence of hydronephrosis or hydronephrosis. The kidneys are macroscopically and microscopically normal.

The establishment of the communication between ureter and bowel at the second operation is accomplished with a minimum of healing surfaces. The blood supply to the healing mucosal edges is unimpaired and so fibrosis must be minimal. Urine flows freely into the proctoscope as soon as the opening is made between the ureter and bowel. At no time has there been anuria during the second postoperative period. The urea content of the blood rises somewhat in the course of a few days and fluctuates from day to day apparently depending upon the amount of water and nitrogenous material reabsorbed from the bowel. Intravenous urography again reveals normal outlines of kidney pelvis and ureters.

SUMMARY

1. A new technique is described for uretero-enterostomy.
2. Complete surgical asepsis is maintained.
3. Healing between ureter and bowel in the absence of infection is insured.
4. A non fibrous, patent communication with a check valve control is established between ureter and large bowel.
5. Postoperative dilatation of the urinary tract has not occurred.

The author wishes to acknowledge the able assistance and helpful suggestions of Dr. H. E. Shiff, of the Peiping Union Medical College during the latter part of the investigation.

EDITORIALS

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APRIL, 1935

INFECTIONS OF THE HAND

IN spite of the contributions and teachings of Kanavel in Chicago of Auchincloss and his students in New York of Bunnell in San Francisco and of many other interested workers in many parts of the country the toll of time money and loss of function taken from the working man in particular as a result of infections of the hand is still far greater than it should be.

There are doubtless a number of factors responsible for this condition. One important one obviously is the lack of knowledge on the part of the public with reference to the proper treatment of open wounds. Too often the first thought that occurs to many an individual who has sustained an open wound of the fingers or hand is the confident assurance that has come to him over the radio only the day before that if he will only be modern, and apply listovapopepsogone solution liberally to the open wound the outcome will be all that could be desired. Nor can the medical profession claim complete immunity to the siren wiles of the purveyors of merchandise. One

need only recall the long list of 'ideal' antiseptics and of healing ointments, now almost forgotten to realize how credulous we have been in the past.

Another factor deserves still more thoughtful consideration. The care of infected hands is often relegated to the young and inexperienced surgeon. Particularly is this likely to be true in our large public institutions. The chiefs of the service cannot be bothered with the care of trivial conditions; they must center their attention on major surgery. The assistants take their cue from the chiefs; the contagion affects the residents in turn and the patient eventually finds himself in the hands of the inexperienced junior interne. Too often not until some ill advised incisions have been made and not until the pathological process has advanced to such a degree that it is obviously a matter of grave concern are the older members of the staff called in and the thoughtful attention that might have averted serious trouble if aroused earlier concentrated on controlling what has become a life threatening infection or on attempting to save the seriously injured structures so essential to normal function.

This condition reflects in turn an attitude which prevails in many medical schools. So much attention is devoted to thyroid surgery, surgery of the biliary tract, of the digestive tract, etc., and perhaps to the rare and dramatic surgical lesions that are engaging the attention of some member of the surgical department that little time is left for consideration of the more prosaic but surely much more important conditions resulting from wounds and infections. As a result, the student con-

fronted with such cases at the outset of his hospital career has no definite conception of the problem involved or how to meet it

A member of the surgical department of one of our large medical schools was asked recently whose duty it was to consider with the students the problems of infection and injury. After a moment's thought he replied "I don't believe there is anyone in our department who is particularly interested in minor surgery. As long as infections of the hand and in fact infected wounds of any part of the body are considered minor surgery we will not make much progress in the surgical care of patients with infection and injury."

It should hardly be necessary to repeat what every first year medical student knows, and what the senior student too often has completely forgotten, that the hand is a marvelous and intricate mechanism. When this delicate mechanism is entrusted to the care of the novice in surgery, armed with a sharp scalpel and an urge to "do things," the result is often unfortunate.

The remedy, I think, lies in our own hands. It involves

1. Greater emphasis in our surgical teaching upon basic surgical principles and more specifically upon accurate diagnosis and proper treatment in cases of infection and injury.

2. Proper emphasis on these problems in the hospital and delegation of the responsibility for their solution to the most experienced men on the staff. It is interesting and stimulating to read a plan for organization of the surgical service of the hospital so that the patient with a postoperative pulmonary embolus can be operated upon promptly and given a chance for life.¹ But from the standpoint of our obligation to the public, and of accomplishing the greatest good for the greatest number, is it not imperative that the sur-

gical service should be organized so that patients with infection and injury can receive prompt and truly skillful attention?

3. Education of the public to the fact that in the immediate treatment of injuries simple soap and water cleansing and protection of the open wound against infection from without, with the aid of a sterile dressing constitute the best possible form of first-aid treatment and one which is based on sound surgical principles.

STANLEY L. KOEN

JEJUNOSTOMY FOR RESTORING ELECTROLYTES LOST IN PERSISTENT VOMITING

IN the average instance, postoperative vomiting is readily combated by the well known routine of the indwelling stomach tube and the maintenance of water balance by administrations in the veins, under the skin and by rectum. The unusually prolonged and unyielding type of postoperative vomiting presents an entirely different problem. It is a question whether the surgical profession broadly speaking appreciates all of the factors concerned in a favorable or unfavorable response to treatment. In the work of the average surgeon a year rarely elapses without his experiencing one or more instances of excessive and prolonged postoperative vomiting and encountering therefrom an unexpected fatal outcome.

The usual story is that vomiting becomes excessive about the fifth day and that in spite of gastric decompression by indwelling tube and maintenance of fluid balance by administration of saline and glucose solutions in the veins the vomiting continues, thus resulting in a tremendous loss of gastric and intestinal juices. With this excessive vomiting the abdomen shows no distention (often remaining flat) and frequently reveals peristalsis in the lower coils. There are occasional bowel move-

¹Leventhal, H. Preliminary jejunostomy, the need of operation for prompt surgical intervention. *J. of the Am. Med. Assoc.* 1915, vol. 4, 234.

ments. The surgeon after futile search, can find no explanation of an obstructive character for the continued and excessive regurgitation. The patient continues to lose in circulatory strength blood volume, and suddenly in a few hours goes down hill rapidly to a fatal outcome. Evidently in these cases there is some type of mechanical block probably edema near or at the duodenojejunal junction. With obstruction at this point, vomiting immediately entails a total loss of all the digestive juices. Experimental work has definitely demonstrated that life is impossible without pancreatic juices, that with persistent vomiting not only is the pancreatic secretion lost but also the electrolytes (sodium and chloride ion) from the duodenal and gastric juices and in addition there is loss of the bile and other intestinal juices secreted by the mucous membranes. Some authorities contend that loss of the bile salts which activate the lipases and aid in the emulsification of fats in the intestines is more serious than the loss of sodium and chloride ion.

Rowntree has estimated that the secretion of digestive fluids averages from 5 to 7 liters daily. Thus in prolonged excessive vomiting not only is there a tremendous loss of water but more important there is the loss of the electrolytes and the hormones of the pancreatic secretion without which life is impossible. Surgeons generally are familiar with the invariably fatal outcome of prolonged duodenal fistula. This of course entails loss of pancreatic fluid and electrolytes with the resulting acidosis of the uncompensated type. Prolonged excessive vomiting not only results in a loss of bile, pancreatic and intestinal juices, electrolytes and tremendous quantities of water but finally winds up with definite alkalosis from loss of gastric acids. While it is generally conceded that death following this condition is due to dehydration it is more

important for us to remember that dehydration in turn is specifically dependent on the loss of electrolytes together with certain qualities of pancreatic secretion.

Wilkie called our attention to the fact that death in high obstruction is due to loss of all digestive secretions by vomiting. Clinically Brockman has reported remarkable relief from obstructive types of vomiting by the administration of bile in the vomitus by rectum. In the past few years a great many surgeons have adopted the principle of returning vomited digestive fluids back to the patient by rectum yet we must remember that absorption by rectum as compared to the jejunum represents a ratio of about one to four. The principle however should be utilized early in every case of postoperative vomiting. White and Fender demonstrated experimentally that death in animals in simple high obstruction could be prevented by returning the vomited material into the small intestine below the point of obstruction.

This very brief statement of relative facts concerning the fatal outcome in some cases of prolonged and excessive vomiting leads to the suggestion that death might be circumvented in many cases of duodenal fistula or unyielding excessive vomiting from simple duodenal obstruction by the institution, promptly, of a jejunostomy and the return of all vomited digestive juices into the jejunum. We have had the opportunity to observe the efficiency of this method on four occasions and consider that the maneuver of jejunostomy with return of all vomitus into the jejunum is definitely a life saving measure. The step is to do a jejunostomy and connect directly to the jejunostomy tube an indwelling nasal tube which has been passed into the stomach or duodenum. As a rule the drainage of the gastroduodenal juices readily run over through the stomach tube into the jejunal

tube. If there is vomiting with regurgitation around the indwelling stomach tube this should be immediately and totally returned with aid of a funnel through the jejunal tube. There has been no difficulty in the jejunum tolerating as much as one pint of vomitus returned at one time. The general influence on the patient for good is immediately noticeable. It is of course assumed that the electrolytes of sodium and chloride ion together with sufficient water will be administered by vein and under the skin. Often it happens that these routes have been more or less exhausted and the making of a jejunostomy with return of vomited digestive juices will become the determining factor between life and death. Especially consoling is the fact that the jejunostomy provides an avenue for administering water, hypertonic saline, and nourishment without further delay.

Recently a case of gangrenous pancreatitis showed every tendency toward recovery after surgical drainage until the tenth day when vomiting and excessive loss of digestive juices began and none of the usual routine measures would bring relief. Over the previous 10 days parenteral administration of saline solution, water and glucose had supported the patient and this method was now becoming intolerable and insufficient. The question of intestinal obstruction anywhere below the duodenojejunal junction was ruled out and with out further delay jejunostomy was promptly done and the indwelling gastroduodenal tube through the nose was immediately connected up with the jejunostomy tube. All drainage from the nasal tube and all regurgitant di-

gestive juices around the nasal tube were immediately returned to the jejunum. Water, hypertonic saline, and gradually nourishment was given through the jejunostomy tube. The patient's improvement was almost immediate and continued to final recovery. Another case of duodenal and biliary fistula showed immediate favorable response to the return of all the fistulous discharge together with fluids and nourishment to the patient through a jejunal tube.

Surgeons should remember in every case of postoperative vomiting that the loss of digestive juices has a serious effect on blood volume through a sacrifice not only of water but important electrolytes representing inorganic factors in the composition of digestive secretion. Loss of electrolytes means dehydration and dehydration means reduction of the volume of blood plasma and increase of concentration of plasma protein. These physical changes together with increase of viscosity and a rise in the red count must interfere with the function of the blood as evidenced by huge reduction of the oxygen content of venous blood in duodenal obstruction and finally in the development of a lethal alkalosis as proved by the high carbon dioxide combining factor.

The moral is that prolonged and excessive vomiting is often *per se* fatal that jejunostomy with gastric tube hook-up is simple and devoid of danger. Most important, in duodenal fistula or duodenal obstruction, jejunostomy should be done early for restoration of lost digestive fluids before lethal dehydration can take place. ROBERT LEE PAYNE.



L. L. McArthur

MEMOIRS

LEWIS LINN McARTHUR

IN the death of Dr. Lewis Linn McArthur the medical profession lost one of its most distinguished members and the surgical profession one of its leaders.

Dr. McArthur possessed qualities of mind and heart that are not often to be found in the same degree in one person and he had in unusual measure the confidence and respect of all who were associated with him and the love and appreciation of his friends. As a surgeon he never grew old but was interested and interesting to the end.

During the many years I knew Dr. McArthur I was impressed with his surgical acumen and his ability to adapt to the individual patient the surgical procedures to be carried out. He had a rare understanding of surgical pathology and what might be called a flexibility of operative technic. I have seen him in the middle of an operation on recognizing that the procedure he had planned was not best adapted to the case change from one method to another with complete success. He insisted that the tissues at operation be handled with extreme gentleness, and that meticulous care be exercised in all coaptations.

But more than technical skill he had a humane understanding of the emotional states from which the patient suffered. He appreciated the natural desire of the patient not only to feel well but to look well and he wanted to be of aid, in building up not only his physical but his mental condition. In his work he was a marked individualist. He took the most intense personal interest in each case, always visiting his surgical patients at least twice daily.

It would appear sometimes that the modern surgeon thinks of surgery only from the standpoint of the operation, the after-care of the patient and the physical results. He carries out with the most scrupulous attention the necessary technical procedures, but not always does he possess that kindly spirit of helpfulness which is essential to carry the patient through an operation, to instill the confidence and courage which so often bring the patient safely through a crisis he might not otherwise withstand.

Perhaps this characteristic of spiritual understanding comes to those who in their earlier years were successful general practitioners, that is, practicing not only surgery but medicine as related to surgery. Perhaps the ability not only to acquire the confidence of the patient, but to deserve it to see what the patient desires and

needs, comes through the sixth sense we call intuition which in turn comes from wide experience and deep sympathy for and devotion to the patient, giving to the possessor remarkable ability to achieve results.

Dr McArthur had a large surgical practice which took up his time to an extraordinary extent and he was a successful surgeon because his skill and his humanity enabled him to carry many patients through most serious operations. He was a general surgeon to the last but like all general surgeons of the older school the pressure of patients afflicted with certain types of disease compelled him to restrict his work to rather definite fields.

Among Dr McArthur's numerous contributions to surgical science those in which he felt the greatest pride were (1) the muscle splitting incision for approach to the appendix which is usually attributed to McBurney (among the papers found in his desk after his death was a letter dated 1894 from McBurney acknowledging Dr McArthur's priority) (2) the autoplasic fascial repair of inguinal hernias used in the McArthur clinic as standard since 1896 and recently popularized by Gallet (3) the supra-orbital approach to the pituitary (4) the use of the gall bladder or common duct for the administration of fluids (5) the buried catheter method of common duct and ureteral repair (6) the "tobacco pouch" method of nephropexy and (7) the method of rectosigmoidostomy for complete rectal prolapse.

The many scientific papers which Dr McArthur contributed to the various medical societies are a measure of his intense interest and activity in his profession. They are too well known to require discussion. Dr McArthur was a member of his county and state medical associations in Illinois of the Chicago Medical Society of which he was a past president of the Chicago Pathological Society the Chicago Gynecological Society the Institute of Medicine of Chicago the International Surgical Society the Colorado State Medical Association, the Western Surgical Association, the American Medical Association the American College of Surgeons, the Society of Clinical Surgery and the American Surgical Association of which he was president in 1922.

Lewis Linn McArthur was born January 23 1858 in Boston Massachusetts, the son of Major Joseph Hunter McArthur U S Army and Julia Woodworth McArthur daughter of Samuel Woodworth poet, who perhaps was best known through his well-known poem "The Old Oaken Bucket."

In 1878 Lewis L. McArthur matriculated at Rush Medical College and was graduated in 1880. He won first place in the competitive examination for internship at the Cook County Hospital where he served 2 years. On completion of his internship he spent 2 years in Vienna and Heidelberg in postgraduate study before returning to Chicago to take up his life work. He fitted out the first opeonic index laboratory in Chicago and sent his first assistant, the late Dr John Hollister to London for a year about 1900 to study there the method of Wright.

In 1917 he received the commission of Major in the Medical Reserve Corps of the U S Army and he organized and was director of U S Base Hospital No 14 He was made Chevalier of the Order of Leopold of Belgium in recognition of his service to Belgium during the war

Dr McArthur is survived by three sons Dr Selim W Lewis Linn Jr and Billings Meacher McArthur Dr Selim W McArthur was fortunate in receiving his surgical training under his father He has continued on the staff of the hospital where Dr McArthur did much of his life work and he well fulfills the tradition established by his father for skilled and humanitarian service W J Mayo

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REVIEWS OF NEW BOOKS

VOLUME X of the *Cyclopedia of Medicine* now appears and it covers the section *PRE to RUB*. The first subject covered is pregnancy, parturition and puerperium, and the first 30 pages are given to the anatomy of the female generative organs and the pelvis. The next 30 pages cover maternal care, so that a great amount of detail is given to each topic, the whole subject requiring 362 pages. The next section covers the anatomy, physiology and disorders of the prostate and the section on treatment is filled with fine illustrations and drawings. A large section of 600 pages is given to the phases of radiology. Remittent fever, "reticulo-endotheliosis," and "rhubarb" indicate the great spread of topics discussed. The whole volume of 1167 pages is well printed on good heavy paper and bound in a firm, green colored binding. Vols. X and XI conform nicely with the high caliber of the preceding volumes. Volume XI covers subjects occurring alphabetically between the letters *RIC* and *TEL*. Individual topics are contributed by men familiar with the subject so that the associate editors are found widely scattered. The first topic in Volume XI is that of *Rickets* written by Drs. Park, Ebot and Bromer. *Rickettsia*, rubella, saccharin, scarlet fever, silver skin grafting, social service, spinal cord disorders, spleen, sprue, staining methods, stomach including its surgery, strophanthus, syphilis, ending with tar and tartar indicate the scope of medicine, surgery, pharmacology and laboratory methods described. The volume consists of 1111 pages of well printed, well edited material in the conventional rigid binding.

The *Cyclopedia* is edited by Dr. George M. Piersol, and the review of the first seven volumes, which appeared in the December 1933 issue of *SURGERY, GYNECOLOGY AND OBSTETRICS* (p. 822) covers the detail of the plan. M. H. BARKER

STUDENTS and gynecologists alike will welcome this second edition of Curtis' *Textbook of Gynecology*. While adhering to his original idea of having the book reflect his own viewpoint and practice, he has lengthened it by some 107 pages, thoroughly revised the illustrations and increased its written material by about 70 per cent. This is a textbook

and, therefore, covers, as we would expect, all of the frequently encountered gynecological conditions—the infections, the neoplasms, the injuries of childbirth and displacements, and the functional disturbances. Its great value lies in the fact that it is the work of a master gynecologist who presents the subjects of gynecology to us with remarkable clearness, and, considering the size of the volume, with surprising thoroughness. Everywhere he has given us the results of his own rich clinical experience and laboratory investigations. In 4 years there has been naturally a slight shifting of his viewpoint on several subjects, a thing that may be sensed by those who are familiar with both editions. The feature that is perhaps of greatest interest is the chapter on "Internal Secretions." The author has condensed into a chapter about all that is really known about this intricate subject, and it is exceedingly clear and well done. He has at various points in the book sought to couple up this knowledge with the treatment of various disorders. He remarks "despite the meager progress in treatment we are justified in assuming that further developments are imminent. Moreover, dependable tests for early pregnancy, for death of the fetus *in utero*, and for determination of the postoperative cause of chorio-epithelioma merit inclusion in the list of advances made in the care of gynecological patients." RICHARD R. SMITH

A FITTING monument to the work of Dr. Wilmer who is retiring as chief of the Wilmer Institute of Johns Hopkins University is found in *Atlas Fundus Oculi*. The color plates of the fundus are by Annette Burgess, an artist trained by Dr. Wilmer especially for this work, and are made from his own patients and those of a few colleagues. They are beautifully reproduced, and represent a satisfactory variety of conditions seen with the ophthalmoscope. Only one criticism might be made of the illustrations as a whole—the light reflexes, the appearance of nerve fibers in the fundus and that of fine granular pigment appear in some cases to be exaggerated.

The careful description of the normal fundus and its common slight congenital abnormalities such as hyaloid remains on the disc is well done and of great practical value, since, as the author points out, it is common to see these mistaken for various conditions indicating disease. Thus the disc in high hyperopia

THE *CYCLOPEDIA OF MEDICINE*. George Martin Piersol, B.S. M.D. Editor-in-Chief, and Edward L. Borgia, A.B. M.D. Associate Editor. Vol. 10 and 11. Philadelphia: F. A. Davis Co. 1934.

A *TEXTBOOK OF GYNECOLOGY*. By Arthur Hale Curtis, M.D. ed. of Philadelphia and London: W. B. Saunders Co. 1934. First edition reviewed 1933, 51 178.

ATLAS *FUNDUS OCULI*. By Wilmer McLeod Wilmer, M.D. LL.D. Sc.D. Introduction by Warfield T. Lamphere, M.D. New York: The Macmillan Co. 1934.

is properly distinguished from that in early optic neuritis.

The findings in each case are briefly and simply described, with a minimum of discussion as to vexing questions of pathogenesis. Perhaps there is too little discussion of certain conditions. Thus colloid excrescences are described as such, and properly illustrated in Plate 86 yet it might have made the matter clearer to state that they are hyaline deposits on the lamina vitrea of the choroid and hence always very deep in the retina and seen through a certain of retinal tissue. His other illustration on Plate 84 of colloid excrescences seems to represent a somewhat different type of deposits which is located in the retina itself. The author's use of the term *druses*, an Americanization of the German *Drusen*, usually employed as synonymous for colloid excrescences, is here noted by the reviewer for the first time.

The fundus conditions observed in hypertension, arteriosclerosis, nephritis, and diabetes are beautifully illustrated, and brief summaries of physical and laboratory findings in the illustrative cases are included. Enough distinction is not made between conditions due to arteriosclerosis and the type of change called by Fishberg hypertensive neuro-retinopathy which distinction seems to be justified by recent additions to our knowledge of cardiovascular pathology. Especially valuable is the representation in several cases of the changes in individual lesions. A fine example is that illustrating the progress of a solitary tubercle of the choroid in Plates 39 to 41. The book will prove exceedingly useful to one studying ophthalmoscopy, as a reference book in any ophthalmologist's library and especially in institutions where ophthalmoscopy is being taught.

SAMFORD R. GIFFORD

FORMER editions of Jordan's well known student text¹ on histology have been reviewed in this journal. It is a useful student aid of the traditional type which furnishes reliable information on the more static features of tissue structure and organ architecture. Indeed the chief suggestion toward improvement might well be the adoption of a dynamic viewpoint throughout.

Each successive edition has shown some improvement although no radical departures have been made from the original plan, scope, treatment, or phraseology. The present (sixth) edition follows its predecessor closely except for a change in format. A larger page of more richly sized stock has been adopted, evidently to the end of improving the quality of the halftone reproductions. Slight gains for the better have been made in this direction. Any such advantage however is largely offset by the larger, thicker and heavier volume which has resulted. A five pound book is a distinct burden to read, and this volume now outrates all American competitors both in bulk and weight.

A TEXTBOOK OF HISTOLOGY. By Harvey Ernest Jordan, A. M. Ph. D. 6th ed. New York and London: D. Appleton-Century Co. Inc. 1934.

Some pedagogical losses have been incurred in the resetting. One is the placing of all subordinate descriptive matter in full size print. Discussions of blood lymphatic and nerve supply together with many lesser descriptive details, not only would appear to better advantage in fine print but also would help reduce the present cumbersome volume size. Toward the same end a still more drastic change could be made. This would consist in the total elimination of more than 100 pages devoted to a list of illustrations, a chapter on elementary histological technique and a section on detailed laboratory directions designed to fit the author's own course but of no practical value to others. Any loss to the student would be negligible.

The greatest gain in the present edition has been the introduction of some 45 additional or replacing figures. Beyond this the preface is misleading as to the amount of new material presented. The Golgi apparatus, reticulo-endothelial system and neuroglia receive new treatments. The account of gametogenesis has been condensed. Otherwise the reviewer finds almost no changes or new entries of significance.

L. B. ARRY

THE second edition of Kuntz's well known treatise² on the autonomic nervous system will find a welcome in the libraries of many a neurologist. Professor Kuntz has brought up to date the only book of its kind written in English and has thus increased its value as a reference work for those interested in the visceral side of the nervous system. He has rendered a distinct service in furnishing synopses of nearly all the important original investigations in this field and in supplying a magnificent bibliography.

All parts of the book will not share like praise by various readers. Some will feel that such sections as that on the development of the sympathetic system or that on the innervation of skeletal muscle are not unbiased by the author's own studies. Two criticisms of a general sort which are applicable to the book as a whole might be considered. It reads in monotone even to one intensely interested in the subject, a point which quickly discourages students from making as extensive use of the book as they should. One of the reasons for this fault may appear in another: the author fails to deal with subjects as critically as he might. He has not evaluated results of original investigations as carefully as should be done to give life to the book.

WILLIAM F. WENDLE.

THE second edition of Bell's *Pathology*³ contains 140 more pages than the first edition, the various topics are discussed more fully, a large amount of new material has been introduced and an entire new chapter on diseases of bones and joints has

THE AUTONOMIC NERVOUS SYSTEM. By Albert Kuntz, Ph. D. M. D. 2d ed. rev. and enl. Philadelphia: Lea & Febiger, 1934.

A TEXTBOOK OF PATHOLOGY. Edited by E. T. Bell, M. D. 2d ed. Philadelphia: Lea & Febiger, 1934.

been added. But the volume is still more than two hundred pages shorter than its nearest competitor. This is not necessarily a defect, for the book is well written with a commendable economy of words. Any contribution to the subject from the Department of Pathology of the University of Minnesota will command attention, and the present volume is no exception. It is a work of collaboration by E. T. Bell, B. J. Clawson, Hal Downey, J. S. McCartney and C. J. Watson.

Dr. Bell contributes all of the chapters on general pathology except that on "The Mycoses or Fungus Infections." This latter was written by J. S. McCartney and is praiseworthy because of its completeness since it includes several diseases omitted in most of the textbooks of pathology. The chapters on "Diseases of the Urinary System" by Bell, on

"Diseases of the Heart" by Clawson, and on "Diseases of the Blood" by Downey are essentially short monographs on these subjects and fulfill expectations based upon the reputation and experience of each of these authors in the field in which he writes. These are probably the most notable chapters in the volume and are beautifully illustrated.

Many subjects are presented with unsatisfying brevity. But few if any significant facts are omitted, although they may not be fully explained. The junior and senior medical student will be pleased to find listed in the index and at least defined in the text many rare diseases with which his clinical teachers delight to puzzle him, such as Milroy's, Landau's and Krienboeck's diseases. This fact, among many others, justifies the statement of the editor in the preface that the authors "have attempted to present the facts of pathology in such a way that the student will look upon clinical medicine as a direct continuation of his pathological studies and not as an abrupt entrance into a new field."

The surgeon will be interested, among other things, in the discussion of the value of the biopsy and how it should be performed, at the end of the chapter on tumors which was written by Bell. After a brief discussion of the prejudice of many physicians against biopsies, Bell concludes: "If we discard the biopsy it will mean removal of legs for giant cell tumors, radical breast operations for fibro-adenoma and cystic disease, removal of jaws for benign ulcers, etc. Surely the theoretical dangers of a biopsy do not offset its known value." Bell is not impressed with the alleged advantages of grading tumors as it is usually done, on the basis of "the relative number of differentiated and undifferentiated cells." He believes that "the malignancy of a tumor should be judged by its most malignant part and not by its average structure." J. P. SIMONSON

THE textbook of Cowdry¹ brings the freshest breath to the field of histology that has been experienced for some years. Here is a novel attempt

by one of America's foremost cytologists to write dynamic histology to interpret structure through function, and to present a digest of the best contemporary thought. Even the table of contents reflects the physiological approach, as witness the main section heads: (1) water, the essential vital medium; (2) the blood, the principal integrator; (3) absorptive drainage into blood; (4) chemical integration by endocrine products in blood stream; (5) intake of water, nutriment, accessory food factors and removal of waste; (6) oxygen consumption and carbon dioxide elimination; (7) regulation of constitution of blood and removal of waste; (8) rapid neural integration in response to internal and external stimuli; (9) architectural support; (10) perpetuation of the race; (11) unification, protection, and adjustment. From these headings the plan of organization can readily be grasped, and it will be immediately manifest how radically the traditional arrangement has been altered. Furthermore, there is no account of the cell as such. Its various features are discussed disconnectedly wherever they are best illustrated by the subject matter at hand. Even the tissues experience somewhat the same fate. Epithelium is first described under the thyroid gland, while the connective tissues and muscle are discussed in almost the last chapters.

From this superficial recounting of certain obvious peculiarities, it is plain that Professor Cowdry's text is indeed something out of the ordinary. When next the subject matter is scrutinized it is equally clear that no attempt has been made to present a well rounded whole. Tendons occupy eight lines and cartilage less than a page; the ureter gets no specific description, but its innervation is fully discussed; hair, sebaceous glands and sweat glands receive but one and one-half pages, whereas the pituitary gland claims nineteen, the muscles are limited to ten pages, while the blood cells alone take sixty-two.

Any criticism of these departures from the ordinary treatment is partly disarmed at the outset by the preface, from which pertinent quotations can be made to advantage:

The time is passed when a broad, even presentation of the microscopic structure of the whole body is needed. Much that is important must be omitted in order to present the most vital subjects at all adequately. Justification for this is found in comparing standard works on physiology and histology. If the latter many pages are devoted to structures which the physiologist does not deem worthy even of mention. Concentration on a few subjects affords opportunity for the presentation of some of them in their proper setting, for emphasizing the value of experimentation and of what constitutes evidence. What to omit and what to stress is the question. The usual plan is to begin with a description of typical animal cells, then to pass to the animal tissues and finally to the several organs. This is logical and time-consuming. These cells and tissues, likewise, do not come for themselves and by themselves, but function only in so far that they are integrated with the rest. Consequently an attempt is made to build up, as the discussion advances, a conception of cells and elementary tissues as the many arrangements in which they actually exist. Organs and systems are stressed in order to build the principal axes of the volume, which is to relate structure and function as the whole body—stress the real physiological side. A just criticism of most textbooks of histology is that they respectively illustrate the

¹ A TEXTBOOK OF HISTOLOGY, FUNCTIONAL SIGNIFICANCE OF CELLS AND INTERCELLULAR SUBSTANCES. By E. V. Cowdry. Philadelphia, Lea & Febiger, 1915.

obvious. Figures consuming much space merely show at a glance what the actual preparations will lead the students to discover for themselves—a much more healthy experience. They are beyond the picture-book stage. As indicated in the list of contents, the central theme of the book is the blood vascular system—the great integrator. The goal in view is that the students shall gradually visualize more and more accurately the wonderful complexity of the minute structure of the human body in terms of biochemistry, physiology, and pathology and, finally, in practice shall institute measures of assistance with due caution.

Controversial subjects have in no way been avoided, rather have they been sought out and aired. An effort has been made to present the evidence fairly and to acknowledge the labors of leading investigators.

Doubtless some of these viewpoints will not find favor with many teachers, others while sympathizing with their spirit will consider them impractical in application. The reviewer is convinced that our beginning medical students, coming as they do without any definite understanding of even the nature and properties of protoplasm or of the organization of a cell, must learn to creep before they can be expected to walk—to say nothing of running. For this reason he holds that since structure is the primary concept to be gained (before function is made to vitalize such information) a presentation which does not become wholly subservient to an ideal functional continuum is the simplest and wisest to pursue. Otherwise, confusion and discouragement to the beginner is both predictable and certain. On the other hand, with a moderate amount of previous histological experience study of this book should be a thrilling adventure. The greatest value of Professor Cowdry's text will perhaps be as a book in which collateral reading is expected. It would make, for example, an admirable companion volume to the Maximow-Bloom text which is easily the foremost in the orthodox field. With such guides the student will be enabled to get an insight into histology such as has not been possible before through the medium of the printed page.

To the medical practitioner Cowdry's *Histology* can not be too strongly recommended. It is no ordinary compilation but rather a mine of authoritative up-to-the-minute information and interpretation. If the clinician can find a page which does not offer valuable new viewpoints and unexpected rewards, then that man has been a prodigious reader and analyst of current histological literature and can well high qualify as an expert in the subject.

L. B. ARRY

FOR the preparation of his book,¹ Meaker set out to assemble completely the knowledge now well established concerning involuntary sterility, discounting the traditional fallacies and including all the modern discoveries. The purpose was accomplished admirably but this was to be expected because Meaker is one of the foremost authorities on the subject of sterility. The book is divided into three parts. In the first part the author takes up

the causes of human infertility and he discusses them under nine headings. The second part is devoted to the question of the diagnostic study of the sterile mating. Not only are the gynecologic aspects discussed but also the urologic ones. There are excellent chapters on the study of the male genitalia and semen. There are also lucid descriptions and instructive illustrations of transuterine insufflation, hysterosalpingography and postcoital examinations. Three chapters are devoted to endocrinologic investigations.

Meaker points out the value of group study of cases of sterility. In 1927 he formed a clinical group with a urologist, an internist and an endocrinologist in order to study sterility cases more thoroughly. The third part of the book deals with the treatment of sterility and in this section Meaker points out the great value of a clinical group for the intensive study of sterility cases. Before he formed the clinical group the incidence of pregnancy in his sterility cases was 2.6 per cent whereas the frequency of gestation has been 50 per cent in the series of cases studied by the group. Meaker realizes, however, that for many reasons, groups are not feasible in all cities, hence he describes the minimum treatment which a physician can carry out by himself. Urologic as well as gynecologic treatment is outlined. As regards surgery to overcome tubal occlusion, Meaker has had phenomenal success, because of the 19 patients on whom he performed salpingostomy 9 conceived. Concerning endocrine causes of sterility the author found the prognosis to be fair in the pituitary cases, excellent in cases of thyroid deficiency and poor in failure of the ovaries. Contrary to most physicians Meaker has seen good results follow the oral use of anterior pituitary preparations.

Throughout the book there is evidence of the author's comprehensive grasp of the subject of sterility not only of the physical factors involved but also of the psychic ones. Excellent advice is therefore given concerning both factors. The book deals with its subject so completely and rationally that it should be carefully studied not only by physicians who are especially interested in sterility, namely, gynecologists, urologists, and endocrinologists, but also and more particularly by general practitioners.

J. P. GREENHILL

THIS imposing volume² by Brailsford, dedicated to the memory of Sir Robert Jones, constitutes a distinctly important event in the evolution of the literature of clinical radiology. Beautifully printed on excellent paper in large type with well spaced lines its excellent diction literally tempts the reader to linger longer in the study of its rich pages. Chapters are devoted to the normal findings in the skeleton at birth and the various congenital, dystrophic and traumatic factors influencing the rate of ossification and the aberrations from the normal. After

¹ HUMAN STERILITY: CAUSATION, DIAGNOSIS AND TREATMENT. A PRACTICAL MANUAL OF CLINICAL PROCEDURE. By SAMUEL MEAKER. Meaker, M.D. Baltimore: The Williams & Wilkins Co. 1934.

² THE RADIOLOGY OF BONES AND JOINTS. By James F. Brailsford, M.D., M.R.C.S. (Eng.). Baltimore: Williams Wood & Co. 1934.

a few introductory pages of general discussion of the various pathological findings, the major portion of the book is devoted to a detailed study of the various regions of the skeleton and the lesions affecting them. The last hundred pages are devoted to a general consideration on bone changes in systemic and localized disease, and a final chapter on bone tumors. A lengthy bibliography concludes the work.

Special stress is laid upon the value of periodic radiographic examinations in studying normal and irregular growth, in observation of the progress of systemic and localized disease, and before, during, and after the exhibition of various forms of treatment. The lapse of a few weeks may supply the clinician with X-ray evidence of great value, though the preliminary X-ray findings may have been of slight or no value. Apart from setting forth concisely an account of the bone changes seen in health and disease, the author's aim has been to indicate the significance of the roentgen findings. Every effort has been made to include in this work the most recent advances already recognized in roentgen ray departments and journals but not yet adequately appreciated or accepted by general textbooks. In the opinion of the reviewer the task has been well done.

JAMES T. CASE

THE work entitled *Tuberculosis of the Lymphatic System* the author covers the subject in great detail with particular reference to the more common regions of gland involvement. His introductory chapter wherein he traces tuberculosis of the glands back to the early Greek and Egyptian conceptions of the etiology is particularly interesting to the student of medical history.

The author discusses in great detail bacteriology, pathology, chemistry and pathogenesis in this condition. The anatomy of the lymphatics is ex-

tensively described and beautifully illustrated. In the two chapters devoted to the subdivision of cervical lymph nodes, a clear picture is given of their involvement, the pathology, clinical course, diagnosis, and differential diagnosis, and the treatment, medical and surgical.

Of great practical interest is the discussion of tuberculosis of the tracheobronchial and abdominal lymph nodes. The outline of the care of the disease is a résumé of the treatment, in all its phases, and is especially to be commended for the statistical details of medical and surgical results.

This book can be recommended as an excellent text for the student and the general practitioner. The index, which is placed at the conclusion of each chapter is an elaborate and very useful compilation of all recent writings on the subject.

W. A. HARRINGTON

AN *Introduction to Gynecology*¹ is exactly what its name implies. This book was written primarily for third year medical students and is an outgrowth of a series of notes which the author has used for some time. The book is well written, each subject being presented simply clearly and briefly. It will doubtless prove to be a profitable and popular one for students.

This second edition has been made a more complete text by the addition of a short synopsis on treatment in each of the chapters dealing with diseases, although anatomy, pathology, and diagnosis are still emphasized. The bibliographies at the end of each chapter have also been expanded.

Recent advances in gynecology, such as the Friedman test for pregnancy, the Schüller test for carcinoma, and the use of the colposcope have all been included. It is unfortunate that the chapter on the endocrines has not been brought up to date in a similar manner.

RAIMON A. REIS

¹ T. BORN. *LOANS OF THE LYMPHATIC SYSTEM*. Richard H. Miller M.D.
P. A. C. Co. New York. The Macmillan Co. 424

² A. *INTRODUCTION TO GYNECOLOGY*. By C. Jeff Miller M.D. ed. ed.
St. Louis. The C. V. Mosby Co. 214



ALBERT E. ROBERTS

Franklin H. Walker

FRANKLIN H MARTIN

OUT of the hardy pioneer spirit of two families, the Martins of Canada and the Carlins of Pennsylvania each coming west by caravans in the late 1840's and settling on adjacent farms in Wisconsin, grew the friendship and marriage of Edmond Martin and Josephine Carlin, to whom a son Franklin, was born in 1857.

Franklin Martin's childhood was a happy one in spite of the sacrifices of his pioneer forebears the loss of his father in the Civil War and the remarriage of his mother and the uniting of two families of children, the Martins and the Mungers. Under moral and religious influences Franklin developed into a ruddy sturdy industrious lad receiving his elementary education by the sweat of his brow.

Aunt Mary and Uncle Addison Carlin were a dominating influence for good in his life. He worked as farm hand brickmaker carpenter, janitor and later as school teacher. In 1872 he left home for Minneapolis to study. In 1874 he returned to Wisconsin and entered Elroy Seminary. And then he decided to become a doctor.

His first professional hero was Dr McLaren Miller, of Oconomowoc, and, later Dr William Spalding of Watertown in whose office he first worked as janitor, in his spare moments reading a book on anatomy which he memorized.

In 1877 he came to Chicago with just enough money for carfare and tuition, and at the suggestion of Nicholas Senn who signed his certificate of matriculation he entered the Chicago Medical College which is now the medical department of Northwestern University. It was here that he met as instructors Nathan S Davis Sr William E Quine William Byford Ralph Isham John H Hollister, and Edmund Andrews all of whom were a great influence in his medical career. He loved the fire and enthusiasm of Quine Davis and Andrews but he also loved the rockbound stability of John Hamilcar Hollister, who later became his father in law and who was a stabilizing and stimulating influence throughout his entire medical life.

His first domicile as a bachelor with young Frederick Parkhurst was at 1133 South State Street, where they cooked their own meals. During vacations of these years he returned to Wisconsin and again worked as brickmaker, school master and carpenter earning his own tuition and living expenses.

His first meeting with John B Murphy and Lewis Linn McArthur was at the time they were taking Cook County Hospital competitive examinations.

He entered Mercy Hospital where he worked with Dr Lorenzo Potter as an interne in 1880. He received his degree March 30, 1880 at the memorable old Plymouth Church at 26th Street and Michigan Avenue which was to remain his church home until its closing in 1915.

During these medical school days he was given the opportunity to earn some money by caring for the patients of some of his professors. It was during these years at Mercy Hospital that antiseptic surgery and the bacteriologic theory of medicine began to take great hold and he was intensely interested in the first local attempts at the prevention of infected wounds and in the struggle against the spread of typhoid fever which was at that time a serious menace to the health of Chicago.

In 1881 he began his medical practice, boarding with the Lord family at 2227 Wabash Avenue and meeting there his life long friends, Frank Bowles, James Chapman and Charles Nicola. He joined Plymouth Church and met Isabelle Hollister whom he courted and married May 27 1886. To her his autobiography is dedicated and with her he had a long and beautiful companionship. She it was who became the great inspiration of his remarkable career.

WILLIAM R. CURRIE

FRANKLIN H. MARTIN—THE SURGEON

FRANKLIN H. MARTIN graduated in 1880 from the Chicago Medical College which later became the Northwestern University Medical School. He served as an interne at Mercy Hospital, Chicago, during that period in the evolution of surgical technique when little was known of antiseptic surgery and practically nothing was understood of aseptic surgery. At this hospital he received his first practical experience and training in the art of surgery under the tutelage of Edmund Andrews and other masters of surgery of that day. The death rate following major operations was extremely high in this era. The progress in knowledge and his own application of what it taught soon extricated Martin from the paraphernalia of antiseptic technique and he among the first in America began to practice aseptic surgery.

One of Dr. Martin's first contributions to surgery was the founding of a Post Graduate School and Charity Hospital and this accomplishment was predicated upon his understanding of the need for disseminating the rapidly increasing knowledge of aseptic surgery. He recognized that this information must be imparted to the older men in the field who were attempting to carry out surgical procedures in the outlying communities distant from teaching centers. This early thoughtful consideration of the need for the education of the actual workers in the field and his desire to help them was the motivating factor of his later activity in developing organizations for the elevation of the standards of surgery and the continuous education of all surgeons.

During the past twenty years the honors and distinctions he has received as an organizer of the medical forces during the World War and as the instigator and the builder of the American College of Surgeons have led many to forget him as a surgeon. He was however always pre-eminently the surgeon and as such was held in high esteem by the men of the generation with whom he was associated.

In his early work as a gynecologist, before the perfection of aseptic technique made abdominal section safe, he did much to popularize the operation of tying off the uterine arteries through a vaginal incision, thus controlling the hemorrhage and inhibiting the growth of myofibromata. As a result of this operation otherwise hopeless cases were benefited and some cured.

Dr. Martin was a pioneer in experimental surgery on animals. His surgical curiosity led him to turn to an investigation of methods for perfecting a technique for the implantation of the ureters into the colon. The recorded data

of these investigations and the principles he established remain the foundation of all subsequent progress that has been made in this vexing problem. He performed one of the first operations for the removal of a diseased urinary bladder followed by the implantation of the ureters.

Surgical literature abounds with his contributions to a wide variety of subjects. These studies were made largely on conditions pertaining to surgical gynecology.

Dr Martin's surgical acumen was great, and he frequently astonished his young associates by his logical and accurate diagnoses. He was averse to exploratory incisions for information and he never knowingly performed unnecessary or questionable operations. Frequently younger co-workers, who in their enthusiasm suggested operations not clearly indicated, were admonished to be conservative.

While at first the work he did was confined to gynecology, he became one of the outstanding abdominal surgeons of the West. His technique was most meticulous, his handling of tissues gentle and dexterous, though a fearless and rapid operator, he was never over radical, and his conclusions relative to pathological conditions and their operability were based on sound surgical judgment.

In that era when abdominal tumors were not recognized or attacked at an early stage of their growth, many patients came to his Post Graduate Clinic with enormous neoplasms. If the indication for operation was clear with no serious contra-indications, he never refused to give these sufferers relief. A less courageous surgeon would have hesitated. The many excellent results in these seemingly hopeless cases attest the excellence of his judgment and the perfection of his technique. He was ever conscious of the human equation in all of his work.

He was a teacher of surgery from the beginning of his career. Any knowledge he imparted to his classes was founded upon wide reading and upon his personal and practical experience and observation. His clarity of thought and directness of expression made any subject under discussion readily understandable and his deductions were so logical and the conclusions so sound that they profoundly impressed his listeners. His commanding personality and dynamic force enhanced his ability as a teacher and these so impressed his assistants and younger associates that he passed on to them many of his attributes. As a developer of young men during their formative period in surgery, he had few equals among the teachers in this department of medicine. All of the men who were his assistants and closest associates, many of whom later achieved success in their professions, were stimulated by his inquiring mind and influenced by his kindness and generous consideration.

It was in the capacity of a teacher of surgery that he realized the necessity for a broader dissemination of the rapidly accumulating facts relative to practi-

cal surgery. This realization of the requirements of the men in the smaller communities who were doing surgery prompted the initiation and development of the Clinical Congress of Surgeons of North America.

His conception was that the surgeons who had fewer opportunities for study could learn faster and their knowledge of the basic principles of practical surgery would become greater if the chance were afforded them to watch the teachers of surgery and surgeons who had a larger surgical experience at work in their own workshops. Thousands of surgeons in the United States and Canada can bear witness to the value of his inspirational thought which originated in the mind of this Master Surgeon.

In later years came his dream of the American College of Surgeons, which he made a reality. The early vicissitudes and obstacles that were encountered in the organization of this great group of men did not daunt his untiring spirit, he recognized no barrier as insurmountable in achieving his purpose. As a result of his great vision, his courage, his indomitable will to succeed, and his unusual ability as an organizer, he has builded the American College of Surgeons which will endure in perpetuity as a monument to his understanding of the need for continuous surgical teaching in its broadest sense.

Looking back over his completed life, we are impressed with his great vision, his love for his fellow man, his appreciation of the ways to advance human welfare through education, and his untiring energy and industry. His work, as he had outlined and planned it, was finished. His memory commands our respect and admiration for the manner in which he worked to the end with the same aggressive spirit and determination which characterized his long and useful life.

We honor his memory as one of the great surgeons of his generation.

FREDERIC A. BESLEY

FRANKLIN H. MARTIN—THE FRIEND

A faithful friend is a strong defence and he that hath found such an one hath found a treasure. Nothing doth counterail a faithful friend and his excellency is unspeakable—Ecclesiastics I I 14 and 15

THE passing of Franklin Martin removes a unique personality from the medical world. His versatility and the variety of fields in which he labored with such phenomenal success will naturally furnish ample material for an interesting chapter in American Medicine. Many will speak of him as an educator, an investigator, as an organizer and leader of men, but those who enjoyed the privilege of intimacy with him will think first of him as a friend.

It was a characteristic of his early boyhood to attract and attach to him his companions, as with a band of steel, and this power lasted throughout the years of a long and useful life. That the record may be clear, it may not be out of place to recall to the generation of physicians who have known Franklin Martin that he was one of those constructive or creative dreamers whose accomplishments are to be measured far more by what the man himself meant to others than by recital of achievements. From the dreams of this man, whom I have known intimately since 1900, have sprung the greatest surgical journal of the age—*SURGERY, GYNECOLOGY AND OBSTETRICS*—the Clinical Congress of Surgeons of North America, the American College of Surgeons, and the Gorgas Memorial Institute.

How did this come about? I am powerless to suggest an answer other than may be implicit in the personality of one who was a friend and a man. When I say that he attracted friends, the wrong impression may be given, for it was not easy to win one's way into the inner sanctuary. He was by nature sensitive and shy, his approach quiet and dignified, no rush of insincere greeting to all and sundry. But as one came in contact with this eminently sane and simple man, one became aware of his abundant resources, and perhaps suddenly a shy touch of his quiet humor would sweep aside the veil of shyness and let one glimpse the lovable being within. Certain elements we all instinctively recognize as essential in the true friend, among them, first, courage and kindness and perfect candor. Courage was one of his chief attributes. He no doubt believed with Barrie, that it is the lovely virtue—a rib of Himself that God sent down to His children. To those who knew him intimately it is needless to speak of his kindness, his interest in the younger generation, and the promptness with which he recognized and encouraged merit in the younger members of the profession.

He was born on a farm and grew up among surroundings conducive to quiet thought. Much of his constructive thinking was done while walking in the great out of doors, for which his autobiography reveals his wholesome love. Nothing pleased him more than to have one or two of his friends join him in long walks during which he discussed various problems in which he was interested. More than once flashes had come during these happy jaunts that later became basic principles in one of his projects. In his autobiography he mentions the Clinical Congress of Surgeons of North America as having been conceived as he walked the deck of a ship cruising in the Mediterranean and those who have shared such jaunts with him can easily visualize his methods of thought and how his schemes of successful organization were launched. His love for out door life naturally attracted him to golf. His congenial side was at its best with his friends on the golf links, and for many years it was his chief recreation. Throughout this country and abroad there are many who remember and appreciate his charm and a lasting friendship that started on the golf course.

He had a way of attracting and binding people to him in spite of the fact that he was often very frank in discussion. Fearlessness was one of his chief attractions and even in hot argument he could maintain his point without losing his friends. There were necessarily many trying situations that arose during the development and direction of large organizations but his keen insight, resourcefulness, judgment, and sincerity were never questioned, and his policies usually prevailed. When organization was finally effected, his friends remained his friends for his candor and patient courage withstood the storm and stress of the process through which the end had been attained. After all the true estimate of an individual can be best obtained from those with whom he labors daily. His subordinates adored him, labored constantly in his behalf and respected his strict discipline, knowing full well that he observed equally with them the rules governing the organization.

No man liveth to himself alone and it would be wholly ineffectual to offer such comments as I can make upon Franklin Martin without acknowledging in full measure the help he had from the very remarkable woman, his wife, Isabelle Hollister Martin. How well they understood each other, how much he deferred to her judgment, how wise she was in counsel, and how prompt he was to abandon certain problems of which she did not approve. Very few who did not know them intimately could appreciate how much she figured in his life, how necessary she was to his happiness, and how much his success has been due to her sound judgment, loyalty, and companionship.

Franklin Martin has left a splendid heritage to the medical profession. No bequest could be more useful than the sound principles he enunciated and wove into the fabric of the institutions he evolved for the benefit of the human race. To me the greatest inheritance is *The Joy of Living*, an *Autobiography*, which

typifies the man and the friend—for it expresses his attitude toward life. If one has read this fascinating book one will find how beautifully it expresses his ideas and it shows, too, the real worth of the man and his confidence in his eventual success. From the very start of his life there is no note of appeal for sympathy, for the hardships he endured, no appeal for pity, but through the narrative, as through his daily life, running like a thread of gold woven into it, there was *real* joy of living. And because of his simplicity, goodness, honesty and sincerity, I know of no man in civil life who could, by the mere suggestion of needing or wanting them, summon more true and influential friends to his side.

The loyalty of his thousands of friends should be a pledge to foster and bring to full fruition the ideals and aims to which he devoted his life.

C. JEFF MILLER.

FRANKLIN H. MARTIN AND SURGERY, GYNECOLOGY AND OBSTETRICS

DR. MARTIN was fundamentally an idealist. A close personal and professional association for thirty five years gives me some authority to speak. Few members of our profession have been more misunderstood. This misunderstanding arose because he was possessed of an extreme sensitiveness and a reluctance to approach people or speak in public that to many will seem unbelievable. As a result of this characteristic he often seemed autocratic, though this was a pure defense reaction. His own unintentional disclosure of this trait is found in a sentence taken from his autobiography, *The Joy of Living*. In speaking of his hesitation in beginning his first laparotomy he said, "Was I a coward?" This was a bracing thought. "Have the courage to do the thing you believe to be right but that you are afraid to do." It became my slogan—a sentiment that during all my life has urged me to action a few times (I hope) with success and many times (I am sure) to my detriment.

His mind arrived with lightning speed at logical conclusions that most of us reached only after prolonged deliberation. His impatience drove him forward without the help of the support that would have come had he been content to wait until more slowly reasoning minds had caught up with him. This impatience helped to give the impression that his actions were often autocratic.

He had little or no desire to accumulate wealth. Money meant nothing to him but the means of establishing the children of his imagination. He realized however that for them to succeed and to attain permanence they must be placed upon a secure financial foundation. This is well illustrated by an account of the origin of SURGERY, GYNECOLOGY AND OBSTETRICS and of his plans for its ultimate disposition.

In December 1904 Dr. Martin invited Drs. F. A. Bealey, William R. Cubbins, John Hollister, and myself to his home at 3210 Lake Park Avenue, where he outlined his plan for the founding of the journal. His conception was of a journal divorced from any commercial association which should be founded, owned and directed by members of the profession. It was to be an example of the best art of printing; it should present in adequate form the new developments of surgical science but should always be a practical journal for practicing surgeons. It should be based on sound financial principles yet never seek to pay dividends to stockholders; it should rather use any profits to increase the service of the journal and insure its stability.

Thirteen Chicago surgeons supported these altruistic principles by subscribing for small blocks of stock. Later when Dr. and Mrs. Martin began to plan for the disposition of the journal they purchased this stock at a profit to the original stockholders.

During thirty years under Dr. Martin's direction the journal has adhered to this original conception. From the beginning Mrs. Martin has held a large part of the stock and she also has been in full accord with Dr. Martin's ideals. Because of Dr. Martin's wise planning the journal now rests upon a secure financial foundation and owns the land and buildings at the corner of Rush and Erie Streets which adjoin the College of Surgeons.

Dr. Martin's manner of administering the various organizations for which he was responsible may be illustrated by relating his conversation with me when organizing the journal. He called me to his office and said "I want you to assume charge of the scientific pages of the journal. Make the journal the best in the world scientifically and artistically. Do not be influenced by any body or anything except the quality of the contributions and the limitations of space. That's all." While he always took a leading part in any expansion or new activity, yet never in the thirty years did he let personal friendship, expediency, or advertisers betray him into seeking to influence the acceptance of any article. Nor did he interfere in any way with the administration of the department. It was the same with other associates. He expected results but gave complete freedom of action and support in any difficulty. His loyalty to his associates and friends was so great that not infrequently it surpassed what should have been expected. Except in the face of incontrovertible evidence of incompetency, he defended them both privately and before the public.

The first number of SURGERY GYNECOLOGY AND OBSTETRICS appeared on July 1, 1905, with the leading article by the chief of the Editorial Board, Dr. Nicholas Senn, upon "Iodine in Surgery with Special Reference to Its Use as an Antiseptic." The ideals of its founder and the character of the journal soon brought contributions from leading surgeons of the United States and Canada and from abroad in sufficient number to insure the journal's immediate success.

In 1908 a British edition was established under the editorial guidance of A. W. Mayo-Robson (later Sir Arthur) and other leading British surgeons. Five years later, after much thought, the INTERNATIONAL ABSTRACT OF SURGERY was added. It was determined that the ABSTRACT should be not a mere desultory collection of material but a discriminating selection from the world's literature by a board of specialists. Arrangements were made with the leading abstract journals abroad for the early exchange of their material. As a result a complete bibliography of the world's surgical literature has become a part of the ABSTRACT.

After Senn's death Dr. John B. Murphy, whose enthusiastic support had been no small factor in establishing the journal, became chief of the Editorial

Board Upon his death he was succeeded by Dr William J Mayo For many years Dr Mayo was in active charge of the Editorial Department To his vision and judgment has been due the discriminating character of the editorials Lately Dr Donald C Balfour has successfully assumed this responsibility

Although the chronicling of scientific progress has been its primary objective, the journal has sought also to foster the cultural aspects of surgery and to honor those who established and perfected its principles Under the supervision of Dr Alfred Brown, 'Old Masterpieces in Surgery' acquainted the oncoming generation with the history of surgery Under the direction of Dr William J Mayo and Dr Donald C Balfour the department of "Master Surgeons" has recorded the achievements of the surgeons of the western hemisphere and aroused our pride in their accomplishments

The journal is known and read wherever medicine is practiced It has a large number of subscribers abroad and penetrates into little known centers in Asia, Africa, and the islands of the Pacific The medical libraries of the world have its numbers filed as a permanent record of the advances in surgical knowledge during the fruitful period spanned by the publication of SURGERY GYNECOLOGY AND OBSTETRICS

It has been the desire of both Dr and Mrs Martin that after their deaths the journal with its real estate should become by gift the property of the American College of Surgeons Since the holdings of Dr Martin at the time of his death in conjunction with the personal holdings of Mrs Martin gave them complete ownership of the stock their desire may be accomplished

The regents of the College believe that this final service of Dr and Mrs Martin to the College and the profession may be made a worthy memorial to Dr Martin's vision and ideals.

ALLEN B KANAVAL

FRANKLIN H. MARTIN AND THE AMERICAN COLLEGE OF SURGEONS

FRANKLIN MARTIN died Thursday March 7 in Phoenix, Arizona, where up to a few days before his death he was occupied with the affairs of the American College of Surgeons especially with preparations for the next Clinical Congress to be held in San Francisco in October

We do well to pause to pay tribute to this great leader to whom more than to any other individual the American College of Surgeons is indebted for its foundation and its development during the twenty two years of its existence With courage, imagination wisdom unflinching loyalty to the best interests of the College and with rare executive ability Dr Franklin Martin as Director General has guided its destinies

It is fitting at this time to review briefly the history of the College—a history which will be his finest monument—for his name is indelibly inscribed upon each of its multifarious activities

At the time the American College of Surgeons was founded and earlier many surgeons, particularly the members of the American Surgical Association had felt the necessity for an organization of the active surgeons which would standardize the practice of surgery To this end at the Clinical Congress of Surgeons of North America held in New York in 1912 an organization committee was appointed Thus the American College of Surgeons is the direct outgrowth of the Clinical Congress of Surgeons a Congress which was originally fostered and promoted by Dr Franklin H. Martin who suggested the formation of this organization committee of the College

Confronting this committee were two lines of procedure (1) to follow the pattern of such an organization as the Royal College of Surgeons in England and admit members only on examination or (2) to admit to Fellowship all the members of the sixteen principal societies representing surgery and its various specialties as a nucleus for the whole and then to add to that number all those surgeons in all parts of the United States and of Canada who by their training experience and achievements were surgeons in good standing

The second of these plans was adopted by the organization committee and it at once became evident that unless the College were to grow very slowly it would be necessary to make a survey of the practicing surgeons throughout the country to determine who were qualified to become the first members of the College

Such a survey was made principally by Dr Martin who visited all the leading medical centers throughout the United States and Canada. As the result of this survey, four hundred and fifty prominent surgeons met in Washington on May 5 1913, adopted the By laws rules, and regulations suggested by the organization committee and elected the first officers of the College, and the Board of Regents and Board of Governors. The original Board of Governors was comprised of the four hundred fifty founders of the College, but the By laws provided for a permanent Board of one hundred fifty members to be divided into three groups, fifty members to be elected by the Fellows at each annual meeting of the College. The government of the College was to be centralized in a Board of Regents whose decisions would be carried out by a Director-General. The recommendations for further Fellows of the College were to be made by credentials committees representing each state of the United States and each province of the Dominion of Canada. This plan was adopted at the organization meeting. Soon after the organization of the College it was decided that the College should endow itself by asking each Fellow to subscribe five hundred dollars to be paid in a lump sum or by payments of not less than twenty five dollars a year.

By this rapid start in membership and in financial support the College had a forceful momentum and was able at once to launch forth on its campaign to carry out its original purposes which are stated in the following summary of a clause of the Articles of Incorporation published in each *Year Book*. "The object for which it is formed is to establish and maintain an association of surgeons, not for pecuniary profit but for the benefit of humanity by advancing the science of surgery and the ethical and competent practice of its art.

It is my opinion that when the College was organized there was no one man who could have equaled the performance of Franklin Martin as Director General for more than to any other one man. The credit belongs to him for the foundation of the College its organization for the rapid mobilization of surgeons to form its constantly increasing membership the shaping of its policies, the solving of the many difficult executive problems which have repeatedly presented themselves. In addition to his many official trips throughout the United States and Canada, Dr Martin has promoted the interests of the College in South America and in Australia by personal visits.

Throughout these twenty two years, I have had the opportunity of observing the constructive genius of Franklin Martin at close range. I should say that except for his peculiar talents the College would not be in its present position. Franklin Martin undertook every bit of the leadership that was delegated to him and often initiated new projects. The whole picture has constantly been one of rapid construction and of militant progress, as exemplified by the many activities of the College and by the work of its Department of Hospital Standardization the Registry of Bone Sarcoma, the Committee on the Treatment of Malignant

Diseases the Committee on Fractures the Board on Industrial Medicine and Traumatic Surgery the Department of Clinical Research the organization of Cancer Clinics the Regional Meetings the annual Clinical Congress the Library which is ready to serve each Fellow by literary research and the Board on Medical Motion Picture Films

In addition to a very high level of efficiency we have our property in Chicago which aggregates in value more than two million dollars—assets which include the endowment fund land buildings and equipment

The very characteristics which have made these achievements possible inevitably sometimes seem too aggressive but in a formative period they are necessary even though they may arouse some antagonism. A lively imagination courage spirit of adventure outstanding executive ability great loyalty to a cause can never be outweighed by lesser qualities. Such characteristics speak for themselves in outstanding achievements

Dr Martin not only was intensely loyal himself but was able to inspire loyalty in those associated with him as is demonstrated by the fact that the Editorial Board and the business personnel of SURGERY GYNECOLOGY AND OBSTETRICS have remained practically unchanged since Dr Martin founded this journal with the exception of those called by death and the outstanding characteristic of the working staff of the American College of Surgeons has been its long time loyalty to its Director General Those who knew Franklin Martin best, trusted him most

All through his life and despite every disguise Franklin Martin has been shy fearless imaginative, idealistic and a dreamer Long will he be known among the great dreamers in medicine He dreamed a dream and the greatest surgical journal in the world was born he dreamed again and the Clinical Congress of Surgeons of North America appeared he dreamed yet again and the American College of Surgeons came into being

GEORGE CRILE

FRANKLIN H MARTIN AND THE GREAT WAR

FRANKLIN H MARTIN was, for half a century one of America's distinguished surgeons, more than that, he demonstrated to an unusual degree the rare gifts of administrative genius and vision. It was logical then that when the clouds of war began to hover over our land with characteristic foresight, as Secretary-General of the American College of Surgeons he should tender the services of that organization to the Surgeon General of the United States Army to aid in re-organizing and enlarging the Medical Reserve Corps. With the acceptance of this timely offer two thousand Fellows of the College, of military age immediately enrolled in the Medical Reserve and until the Armistice was signed this great organization of surgeons took the lead in every wartime medical program.

On August 29 1916 through the enactment of the National Defense Act President Wilson was authorized by Congress to appoint an Advisory Commission consisting of seven persons especially qualified in their respective fields to co-operate with the Council of National Defense in its task of mobilizing the resources of a nation dedicated to peace into a fighting force sufficiently powerful to stay a foe trained for centuries in the arts of war. Through the persistent endeavors of the Committee of American Physicians for Medical Preparedness representing the American Medical Association the Congress of American Physicians and Surgeons, the American College of Surgeons, the Clinical Congress of Surgeons of North America, and the American Surgical Association totaling a membership of ninety thousand medical men the President was convinced that the medical profession should be accorded a place on the Advisory Commission. The question then arose who, among the members of the scientific medical profession was qualified to fill this important and exacting post?

Franklin Martin was the unanimous choice of the committee and in October 1916 he was notified of his appointment by President Wilson.

The Council of National Defense consisting of six members of the Cabinet Secretary of War Newton D. Baker, Secretary of the Navy Josephus Daniels, Secretary of the Interior Franklin K. Lane, Secretary of Agriculture David F. Houston, Secretary of Commerce William C. Redfield, and Secretary of Labor William B. Wilson held its first meeting in Washington on December 6 1916 with the seven members of the Advisory Commission, Daniel Willard, president of the Baltimore and Ohio Railroad, Hollis Godfrey, president of Drexel Institute, Howard E. Coffin of Detroit, Bernard Baruch of New York, Julius Rosen

wald of Chicago Samuel Gompers, president of the American Federation of Labor and Dr Franklin H Martin

Commenting on the sentiments of the commissioners on this occasion Dr Martin said

We, as members of the Commission, had arrived in Washington with somewhat vague conceptions of our duties. We met the six members of the Council, who were equally vague as to our responsibilities, but we rapidly became acquainted. Each gave his idea of the requirements of the situation and of the immensity of the task that we must assume—and then we realized that our group in joint action, would virtually become a War Cabinet, which should not only advise but plan, execute and direct the activities of our Government in its preparation for defense in the greatest war of history. No commissioners ever entered Washington at the call of a President with more humility and with less concrete knowledge of what they were expected to accomplish.

However Franklin Martin shouldered the responsibilities of the post assigned him with characteristic eagerness, and immediately proceeded to formulate a program that would be operable when and if we were drawn into the world conflict. His department in the Council of National Defense was one of the first to establish a routine that functioned with clock like precision until April 1, 1919. The outstanding men and women in medicine and the allied specialties in association with him gave the utmost of their talents and abilities to uphold the well known devotion to service of the medical profession. Under his direction the medical resources of the nation were so adequately mobilized that a steady flow of men and materials perfectly synchronized as to supply and demand, was at all times available.

The General Medical Board of the Council of National Defense, of which Dr Martin was chairman, included the leaders in medicine, dentistry and nursing from civil life. This Board with the Surgeons General of the Army, Navy and Public Health Service and the chairman of the American Red Cross, guided the policies of the special committees composing the Medical Section of the Council of National Defense. These committees, more than a score in number, included the medical, dental and nursing professions, and covered every angle of medical preparedness. In addition to the Washington organization state and county committees co-operating with other defense agencies extended their activities into every town and hamlet in the land.

As a result of this co-ordinated effort, the General Medical Board and its subsidiary committees, more than any other one agency may be credited with the splendid showing of the medical profession in its voluntary enrollment for service. In November of 1917 there were 440 medical officers in the Army and 329 in the Navy. At the armistice there were 30,591 medical officers in the Army and 2,570 in the Navy. And in the Volunteer Medical Service Corps, an organization of physicians barred from active duty because of age, physical disability or

home responsibilities 72 219 enrolled Likewise in the nursing and dental services, enrollments far exceeded the quota set for an army of five million men

It is impossible in the limited space available here to enumerate be it ever so briefly measures initiated by Dr Martin and the programs in which he participated during the war years He worked assiduously to secure proper military rank for the doctors and nurses in the military services He toiled unceasingly to supply the government with medical men and materials to meet the demands of war His own and foreign nations decorated him—and rightly so—for conspicuous service

During the nearly two years of continuous association with Major General William Crawford Gorgas Surgeon General of the United States Army Dr Martin came to know and admire this modest physician and ultimately a warm and enduring friendship developed between the two After Gorgas death in July 1920 it was only natural that Dr Martin should be one of a group who felt that this man was worthy of a memorial—not of stone or bronze—but a living vital organization which would embody the hope of freeing the world from disease—the object to which the life of Gorgas had been consecrated As Surgeon General of the Army Gorgas instituted the policy of strict physical examination for all recruits with regular check ups at intervals thereafter This resulted in an army of physically fit men to meet the rigors of war and it is a well known fact that our soldiers maintained the highest health rate of all combatants General Gorgas often said to Dr Martin Wouldn't it be wonderful if some day a system of strict physical examination could be applied to our civil population? The story of Gorgas sanitary work in Havana and Panama is familiar not only to the scientific world but to the laity as well So in planning the memorial to perpetuate his name it was fitting that the two great works of Gorgas—personal health and sanitation—should be chosen as the basis on which the Gorgas Memorial should proceed After the institution of an ambitious nation wide program in health education it was characteristic of Dr Martin's foresight that he should vision in the Gorgas Memorial Institute an opportunity for the creation of an international research center in which the countries of Latin America where Gorgas had achieved his magnificent work in sanitation, should have a part Out of this vision has grown the Gorgas Memorial Laboratory in Panama already a recognized research center, underwritten by the United States Government and destined to play an increasingly prominent part in the fight of science against disease

Franklin Martin was above all a good soldier He was brave, he was fearless, he would not recognize defeat and once he had determined on a course his generalship untiring energy, and fighting force could be depended upon to see him through to a successful conclusion

CARY T GRAYSON

FRANKLIN H. MARTIN—THE MAN

TO paint a word picture adequate of Franklin Martin, a man who as he matured became the greatest organizer which the past fifty years of medicine has produced a man honored by his profession decorated by his own and foreign governments, is indeed a difficult task. However as it was my privilege for many years to enjoy his close friendship to me the task becomes a labor of love.

There are many qualities common to those among men who leave their names conspicuously high on the rolls of achievement of the era in which they have lived. Oft included in these are the circumstance of lowly birth and early struggles against privations combined with integrity of mind indomitable will and other steadfast qualities. There are however deeper influences which must predetermine a man's ultimate worth and nature having endowed Franklin Martin with the rugged qualities of strong character gave him also a fineness of sensibility which tempered his thoughts with keen discernment and his judgment with unfailing fairness and justice.

We see him in his youth with the spirit of D Artagnan recognizing no obstacles as insurmountable and ready for life's adventure with a happy heart. We see him passing through life retaining this happy heart and always sharing it with others. We see him at eventide with the spirit of youth and merriment still retained and then understand why it was he who wrote *The Joy of Living* for life to him had been a joy. It was not alone the joy of achievement which for him produced satisfaction for no one labor was ever finished before his restless brain had conceived or he had had another thrust upon him. It was that joy which comes from doing for others which was the motivating force behind him. And the extent of his work for others is the true measure of Martin's greatness.

In each of the great activities in which he played such a major rôle it was his clear vision which insured their lasting success. Martin had the unusual combination of not alone being an organizer but having the added quality of being able to make his organizations functionate peculiarly well after he had built them. As he was progressive in his thought, so were his organizations. Not only did they fulfill the objectives for which they were designed but became active influences for advancement with changing progressive thought. This again was evidence of his farsighted vision.

The spirit of his soldier father who sacrificed his life in public service during the Civil War influenced Martin throughout his life. He was ever ready to aid

civic organizations and took part in many projects to advance the welfare of Chicago. He was intensely loyal to his alma mater, Northwestern University of which he was a trustee for a decade, and he was an active member of the various organizations which served its alumni. He gave to the U S Army Industrial College, the Fuel Conservation Institute, and the Board of Education of Chicago much time and thought. He was international in his outlook, and participated with enthusiasm in the deliberations of the Committee on Co-operation in Latin America, the Chicago Council on Foreign Relations, the American Academy of Political and Social Sciences and the Italy America Society.

Martin had an extraordinary ability to appreciate immediately which were the most important details of any problem and to recognize instantly the right thing to do under adverse conditions. There are many instances which I might relate which are indicative of this. One, however, stands out rather vividly in my memory. On a certain night shortly after the First Liberty Loan Drive had been started, he and I were at a Broadway theater. Between the acts a drive was staged and the men who were soliciting subscriptions were meeting with poor success. At that time Martin was interested in stimulating enlistments in the Medical Reserve Corps of the United States and the lukewarm reception which the audience were giving to the request for subscriptions disturbed him. He became restless and told me he must help the men on the stage stir up some enthusiasm for the Loan. He was dressed in his Colonel's uniform and as he arose from his seat to offer his subscription, standing alone in that audience with his soldiery carriage, his chiselled face and flashing eye he made an instantaneous effect on the audience, a sight never to be forgotten. He offered his subscription for the bonds and as the audience went wild with applause not to be outdone by the soldier, they made the drive in that theater that night one long talked of. As he reseated himself beside me, he leaned over and whispered, "God knows how I'll ever pay for them" but he had saved the situation.

Martin will go down through the pages of American history as a courtly man ever actuated by the strongest principles of high Americanism. He had the simple faith of his forefathers with a strong pioneer spirit. Whenever he fought for his beliefs he was a foeman worthy of his adversary's steel. He was a rare combination of stern forcefulness and sympathetic kindness, and I believe no more fitting description of Martin as a man could be made than by a summing up in two words. Franklin H. Martin—Surgeon and Gentleman.

Sunshine was he in the winter day
And in the midsummer coolness and shade

J BENTLEY SQUIER.

BIOGRAPHICAL OUTLINE

Born in Ixonia, Wisconsin, July 13 1857 son of Edmond and Josephine (Carlin) Martin
Died in Phoenix, Arizona, March 7 1935
Educated in public schools and academies of Wisconsin
Northwestern University Medical School, M.D. 1880
Interne Mercy Hospital, Chicago 1880-1881
Member of Staff South Side Dispensary 1883-1888
Married Isabelle Hollister (daughter of John Hollister a founder of Northwestern University Medical School) May 27 1886
Professor of Gynecology Polyclinic of Chicago 1886 1888
Organized, with Dr W. F. Coleman the Post-Graduate Medical School and Hospital of Chicago 1888
Gynecologist, Woman's Hospital, Chicago for many years from 1887
Organized the Charity Hospital, Chicago 1889
Organized SURGERY GYNECOLOGY AND OBSTETRICS 1905 the INTERNATIONAL ABSTRACT OF SURGERY 1913 Editor-in-Chief 1905-1935
Organized the Clinical Congress of Surgeons of North America (now the Clinical Congress of the American College of Surgeons) 1910
An organizer of the American College of Surgeons, 1913 Fellow Regent and Director General, 1913 1935 President 1929
Trustee Northwestern University Chicago 1921-1931 Medical Counsellor 1929-1935
Member Advisory Commission of the Council of National Defense 1916-1921
Chairman, General Medical Board Council of National Defense 1917-1918
Colonel, Medical Corps, U. S. Army during period of Great War 1917-1919 with A. E. F. for three months
Founder and Chairman Board of Directors Gorgas Memorial Institute of Tropical and Preventive Medicine 1921-1935
Honorary Adviser United States Army Industrial College 1925-1935

MEMBER OF MEDICAL AND OTHER ORGANIZATIONS

American Medical Association Chairman, Section of Gynecology and Abdominal Surgery 1895
American Gynecological Society President 1919 Member of Council, 1910-1922
Southern Surgical Association
Congress of American Physicians and Surgeons
Chicago Gynecological Society President, 1894
Association of Military Surgeons
American Medical Editors and Authors Association Member Board of Governors
American Society for the Control of Cancer
American Hospital Association
Northwestern University Alumni Association President, 1931 Director Division on Medicine, 1921-1935
Northwestern University Associates
American Legion Hyde Park Post
Chicago Literary Club
American Association for the Advancement of Science

DECORATIONS HONORARY DEGREES AND MEMBERSHIPS

LL.D. Queens University Belfast 1925 University of Wales, Cardiff 1928 University of Pittsburgh, 1933
D.P.H. Detroit College of Medicine and Surgery 1926

D Sc. Northwestern University Evanston 1927
 Companion of the Order of St. Michael and St. George (C M G) 1919 in recognition of services rendered to the British Empire during the Great War
 Distinguished Service Medal U S 1926 in recognition of services rendered during the Great War
 Commander of the Order of the Crown of Italy 1931 in recognition of aid in founding Loyola Base Hospital, which served the fourth and sixth armies on the Italian front
 Honorary Fellow Sociedad Peruano de Cirugia
 Honorary Fellow Academia Nacional de Medicina de Rio de Janeiro, Brazil
 Corresponding Member Sociedade de Medicina e Cirurgia de Sao Paulo Brazil
 Corresponding Member Sociedad de Cirugia, Buenos Aires, Argentina
 Corresponding Member Academia Nacional de Medicina Buenos Aires, Argentina
 Honorary Member Sociedad de Obstetricia y Gynecologia Buenos Aires Argentina
 Honorary Member Eta Chapter Alpha Kappa Kappa Fraternity

BOOKS AND MONOGRAPHS

Electricity in Gynecology 1890
 Treatment of Fibroid Tumors of the Uterus 1897
 Treatise on Gynecology 1903
 South America from a Surgeon's Point of View (First Edition 1922 Second Edition 1927)
 Gorgias, 1924
 Australia and New Zealand 1924
 The Joy of Living an Autobiography 1933
 Fifty Years of Medicine and Surgery 1934
 Digest of the Proceedings of the Council of National Defense and the Advisory Commission during the World War (Published by the U S Government as an official document) 1934

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SEQUENCES OF EXPERIMENTAL BACTERIAL INFARCTION OF THE FEMUR IN RABBITS

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INFARCTS were produced in the femurs of rabbits by particulate suspensions of charcoal and the sequences in such lesions were correlated with a discussion of some of the more obscure clinical conditions which essentially are focal necrosis of bone marrow tissues (17). The experiments reported demonstrate that infarcts occur in bone in spite of its great vascularity and abundant blood supply and that the metaphyses are more vulnerable than other regions. Since the embolic substance charcoal is extraneous and was injected in relatively large amounts experiments simulating more nearly the conditions occurring spontaneously in bone were undertaken with dead and living bacteria as emboli. By these procedures it seemed possible to produce septic and aseptic necroses of bones where a circulation disturbance (infarction) is the common factor and thus offer an explanation why these lesions occur so frequently in certain locations.

For many years it has been known and generally accepted that osteomyelitis not directly the result of injury, tuberculosis and various forms of so called aseptic necrosis and osteochondritis occur almost exclusively in the epiphyses of bones and the metaphyses of growing bones. The essentials in the production of these lesions and a satisfactory explanation of their occurrence in special regions more often in certain bones have aroused considerable interest. Experimental investiga-

tion and speculation. The evidence available favors that a nutritional disturbance is an important factor in some and infection in others but there is no accepted concept of the details involved.

Lexer and his associates stated that the smaller branches of the nutrient artery of the shaft do not pierce the epiphyseal plates and that the resulting hyperemia and sluggishness of the blood stream favor the deposition and retention of bacteria in the metaphyses. According to Axhausen, Koenig and many others occlusion of one of these terminal vessels may produce infarction of the tissues. This is the most prevalent theory of how hematogenous foci of osteomyelitis occur. Wilensky stated that thrombosis following embolic occlusion of vessels is an important factor. Phemister (29, 30) believed that such an embolus must be infected to produce noteworthy necrosis. According to Wakeley the blood vessels at the actual margin of the metaphysis are in a series of narrow and inelastic tortuous loops an arrangement which favors embolic infarction. Schulze noted that the metaphyseal capillaries have an elongated hairpin shape while the subchondral epiphyseal capillaries form a coarse network with nodular projections toward the cartilage. He assumed that in the elongated capillaries the blood current is slow and that there are no protective cells of the marrow since India ink injected into young dogs was

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absorbed more slowly from the metaphyses than from the diaphysis tissues.

According to Kolodny, Eliason and Ferguson and Harbin and Zollinger one or two small vessels pass from the diaphysis to the epiphysis through the conjugal cartilage but have little significance. Harbin and Zollinger stated that the line may also be penetrated by vessels in rickets and in some other pathologic conditions. Harris (13) demonstrated by cleared preparations previously injected with carmine glycerine that diaphyseal vessels do not pierce the cartilage plates to enter the epiphyses. Vogt (1878) and Jahn (1892) demonstrated that mechanical disturbance or removal of epiphyseal cartilage plates interferes with growth of the long bones. More recently Meisenbach, Haas, Bohlman and others found that various chemical and solid materials placed within the metaphysis decrease the longitudinal growth of bone and that transplants of epiphyseal cartilage do not produce bone. They emphasized the need of a metaphyseal blood supply for osteogenesis. According to the clinical observations of Sever, separation of the epiphysis usually takes place between the metaphysis and the epiphyseal cartilage plate and as a result of the anatomical arrangement

there may be no gross interference with the circulation or viability of the epiphyseal cartilage columns. Occasionally authors have hypothesized the presence of physiological end arteries in the growth centers.

Since osteomyelitis is so much more common in children particularly boys, and often in the extremities, external trauma always has been considered a factor in localizing such a focus. Likewise trauma to the articular surface and subchondral bone tissues of epiphyses is thought by many to be responsible for the various forms of osteochondritis. Such injuries as these are not similar to the trauma of weight bearing during which *coxa vara* deformity at the hip is produced or an epiphysis is slipped resulting from some underlying alteration in the structure of the bone or cartilage. According to Reischauer and his statistics, trauma probably is of no importance in the origin or localization of osteomyelitis or tuberculosis of bone. He considered that these diseases attack the metaphyses because of active cell proliferation and tissue metabolism in certain metaphyses more frequently than others because of a greater rate of growth.

In an extensive review of necrosis in different bones, Harbin and Zollinger correlated these diseases often referred to by various specific names into one group known as osteochondritis of the growth centers. They believed that the etiology of these is unknown but that direct trauma or indirect as a result of increased stress and strain from the body forces seem important while heredity may be a factor. Wardle stated that slipping of the head of the femur may be due to localized osteomalacia which tending to occur in the areas of most recently formed bone weakens the attachments of the epiphyseal cartilage. In his discussion of tuberculosis of bone, Oberzimmer emphasized the resemblance of these cuneiform regions of necrosis in articular extremities to infarcts. These foci are subchondral and usually triangular the base toward the articular surface. He concluded that the genesis of these necrotic regions is not understood and if they are true infarcts, emboli in some of the vessels or an obliterating endarteritis should be found.



Fig. 1. Marked acute aseptic necrosis of the head and neck and medial bending of the proximal end of femur 45 days after infarction by agglutinated killed staphylococci. X7

In his discussions of silent foci of osteomyelitis and chronic fibrous osteomyelitis, Phemister (31-32) stated that these lesions often are metastatic, remain symptomless for a long time, and usually occur near the ends of bones. He said that the etiology of these lesions is not known neither do we know the relation of chronic fibrous osteomyelitis to bone cysts, osteitis fibrosa cystica, giant cell tumors and pyogenic osteomyelitis. According to his views, embolism and infarction may play a rôle in the production of some of the lesions, but pyogenic bacteria of low virulence must also be present because some of the cases of chronic fibrous osteomyelitis reported could not be explained on an aseptic necrosis basis alone. Compère cultured a green-producing streptococcus from a lesion in the astragalus that histologically was similar to osteitis fibrosa. Greenwood, Pease, Phemister, Brunschwig and Day (33) and many others have isolated various organisms from patients with Koehler's, Kienboeck's, Osgood-Schlatter's, and other related diseases which often are placed in a group as aseptic necroses or osteochondritis of individual bones. According to Hallermann, arteriosclerotic changes of the nutrient blood vessels of the upper end of the femur are often associated with osteoporosis of that portion of the bone. It seems that practically all diseases of bone, except those attributed to dietary or glandular disturbances, have characteristics in common

which probably are associated with peculiar structural arrangements of the subchondral tissues that make them more vulnerable than other bone tissues to disturbances in blood supply. The individual differences among these diseases therefore may be based upon the presence or absence of infection, and if infection is present, upon the mass and virulence of that particular organism.

Experimental studies have aided little in understanding fully the infection and necrosis of bone tissues. Senn refers in his text to experiments by Struck, Krause, Mueller and Rodet who injected animals intravenously with pyogenic organisms, usually staphylococci isolated from osteomyelitis, and noted acute suppurative lesions in bones, joints and many other tissues. They often found the foci in bones of young animals near the epiphyses without accompanying fracture or other external evidence of injury. Mueller also produced in young animals a few characteristic foci by injecting tuberculous material. Recently Schulze observed similar results which support the view of Lexer concerning the mechanism of localization of foci in bones. Jackson noted wedge-shaped regions of necrosis in the metaphyses of bones during an attempt to produce arthritis in rabbits by the intravenous injections of streptococci. From his studies of experimental osteomye-



Fig. 2. New bone (involucrum) formation which took place outside the devitalized cortical bone near the proximal end of a femur 8 days following infarction caused by the injection of the agglutinated dead staphylococci. $\times 36$.



Fig. 3. Marked hypoplasia of ossification in the epiphyseal cartilage beneath the head and great trochanter of a femur 8 days after infarction by agglutinated killed staphylococci. Beneath the cartilage plate of the trochanter is a so called line of arrested growth. $\times 10$.



Fig. 4. Marked overgrowth of the central portion of the distal epiphyseal cartilage 8 days after infarction of the metaphysis by agglutinated killed staphylococci. The peripheral portions of the plate received sufficient blood for ossification from the periosteum. \times



Fig. 5. A different level of the metaphysis in Figure 4 demonstrating considerable distortion and scarring of the epiphyseal cartilage plate. Collateral circulation and subsequent ossification have been established from the epiphysis but these extend only to the necrotic tips of the cartilage columns. $\times 11$

litis in dogs, none of which lived longer than 48 hours. Starr concluded that infection starts in the metaphyses, extends along the epiphyseal line to the cortex and periosteum, and probably spreads along the shaft through the Haversian canals. Kuwahata produced abscesses in bones of young but not of adult guinea pigs by injecting a strain of *Staphylococcus aureus* into the heart. The incidence of the abscesses was much greater when the diet of these animals was deficient in vitamin C. He suggested that a peculiar vascular arrangement in the metaphyses and less resistance of the tissues than elsewhere may play a part in localization of the foci. Halde

man and others studied the acute osteomyelitis in animals produced by injecting a culture of a pyogenic organism through an opening in the cortex. Such experiments do not repeat the conditions with spontaneous lesions and do not aid in understanding why pyogenic infections occur in certain regions of bone. It seems there are no controlled observations of lesions produced in bones where living and dead bacteria have been used as emboli, thus determining any relation between bland or septic infarction to focal necroses of bones. Also, the exact location and tissue structures



Fig. 6. Early diffuse septic necrosis in the distal metaphysis of femur 6 hours after injection of agglutinated living cocci. There is a distinct line within the cartilage plate which indicates the level of potential epiphyseal separation. $\times 75$

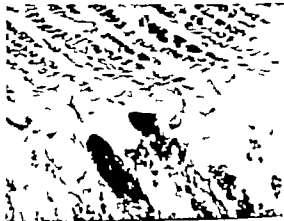


Fig. 7. Masses of living staphylococci wedged in the lacunar spaces between the columns of calcified cartilage matrix of Figure 6. These denote the location of abscess formation in the metaphysis. The extent of necrosis in the epiphyseal line is limited sharply. $\times 22$



Fig. 8. Wedge-shaped acute metaphyseal subchondral abscess of the proximal end of a femur 2 days after receiving agglutinated living organisms in a suspension of charcoal. There is beginning separation within the epiphyseal line. $\times 10$.

of early lesions have not been studied in detail either clinically or experimentally in animals.

EXPERIMENTS

A hemolytic strain of *Staphylococcus aureus* cultured from the blood stream of a man with a subperiosteal abscess and fatal septicemia was injected through the principal nutrient arteries of the femur of rabbits by the method used for infarction of this bone by a particulate suspension of charcoal (17). To agglutinate the organisms and partially or completely sterilize the suspensions from 0.1 to 0.4 cubic centimeter of one tenth normal sulphuric acid were added 2 to 48 hours before injection. The suspensions were obtained by washing 24 hour agar slant cultures with 1 cubic centimeter of normal salt solution. The degree of agglutination usually marked was demonstrated by gross and microscopic examinations and cultures of the suspensions were made at the time of injection. It was thought that mildly septic infarcts compatible with life could be produced by decreasing the number and virulence of organisms acting as emboli.

Rabbits between 3 and 8 weeks of age were chosen in order to study the localization in active growth centers of bland and septic emboli. The agglutinated cocci were forced into the chief nutrient artery of the shaft by



Fig. 9. Multiple subchondral abscesses of the great trochanter and marked necrosis in the metaphysis of the femur in Figure 8. There is beginning liquefaction within the epiphyseal cartilage plate. $\times 9$.

retrograde injection through the femoral artery with other outlets temporarily ligated. In a similar way, the suspension was directed through the deep femoral artery, one branch of which enters the trochanteric notch of the femur, another encircles the capsule of the hip joint and a third becomes the principal source for the vessels in the ligamentum teres. Because of the small caliber of the latter vessels exact and well controlled isolated infarction of the head of the femur was not possible. Material introduced into the principal nutrient artery of the shaft was directed almost entirely to the medullary canal of the diaphysis. A small amount occasionally was distributed to the periosteum.

Each rabbit received from 0.2 to 0.6 cubic centimeter of the agglutinated living or killed suspension and died or was killed from 12 hours to 48 days after operation. A few were injected with non-agglutinated living staphylococci but all died within 2 days. The animals that received killed organisms be

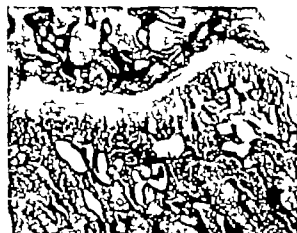


Fig. 10. Acute metaphyseal subchondral necrosis and partial separation of the ossifying portion of the head epiphyseal plate in a femur 14 hours after injection of a partially agglutinated suspension of living cocci. $\times 16$

haved like normal animals except occasionally one favored the injected leg in hopping and held it partially flexed at the knee and hip. Several of the animals injected with living organisms died within 24 hours after operation. Others lived as long as 17 days depending upon the mass injected and the viability of the cocci as determined by culture at the time of operation. The local disability of the leg produced by septic emboli was proportionate to the severity of the osteomyelitis and it varied from slight decreased weight bearing



Fig. 12. Multiple foci of septic necrosis in the distal metaphysis of a femur 2 days after injection of a suspension of partially agglutinated living staphylococci. One focus is situated within the epiphyseal cartilage plate. $\times 75$



Fig. 11. The distal metaphysis of the femur of Figure 10. Necrosis has extended through the joint space anteriorly but not posteriorly where periosteal blood supply is more abundant. $\times 65$

to marked rigid flexion at the hip and knee. A pure growth of staphylococcus similar to the strain injected was obtained from joints with exudate that were contiguous with the femurs injected.

The femurs were fixed in Klotz solution No. 1 containing formalin to 10 per cent, decalcified with 4 per cent nitric acid and cut into proximal, middle and distal segments. These blocks were then doubly embedded in celloidin and paraffin from which sections were cut and stained with hematoxylin and eosin.

As a further control on anemic infarction in the femur in young rabbits and for comparison with embolism produced by this strain of agglutinated staphylococcus, one group of animals received a suspension of charcoal in 5 per cent gum acacia according to the above procedure.

RESULTS OF EXPERIMENTS

Agglutinated suspensions of killed Staphylococcus aureus. Gross examination of injected femurs demonstrated infarction and subsequent changes similar in general to those observed after occlusion of the medullary blood vessels by charcoal and significant of interference with growth of the bone ability to bear weight and of osteogenic reaction within the periosteum. The disturbance in overall length growth of the bone amounted to as much as 2.5 millimeters in 8 days and

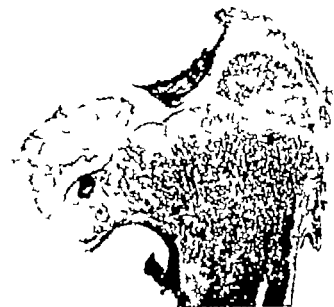


Fig. 13. Complete necrosis of the head and its epiphyseal line and focal necrosis of the neck of a femur 8 days after septic infarction by agglutinated living staphylococci. The short neck is depressed and forms a right angle with the shaft. $\times 5$

this shortening was greatest at the end of the bone receiving the largest amount of the material injected. Femurs infarcted for 3 weeks or more tended to regain this decrease in length. Necrosis in the neck of the femur often produced shortening and medial bending of this portion and allowed the head to droop (coxa vara) and rotate forward. When the head epiphysis was infarcted along with the proximal metaphysis of the shaft it seemed to flatten slightly and overhang the neck at its shelving edge. Occasionally the external surface of the cortex most prominent near one end of the shaft was roughened by new bone and the soft parts were removed with some difficulty. Necrosis was not observed in the knee or hip joint capsules or in the other soft tissues of the thigh after injection of killed agglutinated organisms.

Histological preparations of femurs that received killed agglutinated organisms through the nutrient artery to the shaft demonstrated infarcts and anemic necrosis confined almost entirely to the metaphyses and endosteum. The smaller and more recent infarcts were wedge shaped and were situated in the tissues immediately beneath the columns of epiphyseal cartilage without noteworthy changes in the medullary tissues of the diaphysis or of



Fig. 14. Septic necrosis of the inner and tissue reaction within the outer lamellae of the cortex in the femur of Figure 13. There is also partial necrosis in the adjacent marrow tissues. $\times 16$

the adjacent bony epiphysis. About one-fifth of the epiphyseal cartilage plate along the edge in apposition with the base of the infarct of the metaphysis also was necrotic and a definite line of demarcation was present between it and the remaining living portion. Occasionally there was partial separation within the epiphyseal plate along this line. Large infarcts occupied the entire metaphysis and in these the necrosis was most marked about the columns of ossifying cartilage toward the center of the growth region. The infarcts were poorly stained fragmented medullary tissues and devitalized bone and cartilage with considerable peripheral hemorrhage. When the changes occurred in the cortical bone opposite the metaphysis there usually were similar regions along the endosteum of the shaft elsewhere but still without noteworthy alteration in the medullary tissues of the central portion of the shaft.

Infarcts present for 6 days or longer demonstrated a separation and reorganization process present on all sides of the wedge except at the base beneath the epiphyseal cartilage plate. This consisted of many small blood vessels in a loose poorly cellular and edematous fibrillar stroma that invaded the debris of the necrotic region. It later became more dense fibrous with a few clear spaces and a variable number of osteoclastic giant cells. Compact and spongy new bone was formed when the infarct extended to the cortex and often new osseous tissue was laid down outside the cortex in the form of an involucrum.



Fig. 15. Multiple subchondral abscesses in the distal metaphysis and epiphysis of a femur 7 days after septic infarction. (x45 to eight colonies grew on agar plates inoculated with the suspension at the time of injection.) Foci in this bony epiphysis were unusual. X16

The metaphyseal surface of the cartilage plate remained necrotic until organization of the infarct but the columns above continued to grow without being ossified so that frequently the growth line was as much as three times its normal width. Overgrowth of the cartilage did not occur at the periphery of the epiphyseal plates because of periosteal and capsular collateral circulation. This was especially true at the posterior edge of the distal plate where many muscle tendons insert and at the lip of the head epiphysis where the capsule of the hip joint is attached to the neck of the femur. As organizing tissues replaced the infarcted region and where the blood supply was adequate the long columns of epiphyseal cartilage cells narrowed to about their former length and osteoid tissue and new bone were formed in irregularly arranged interlacing spicules. The level of the metaphyseal surface of the plate at the time of



Fig. 16. Marked deformity, scarring and new bone formation in the proximal end of the femur of Figure 15. There is a distinct line at the level of arrested growth. X75

infarction was frequently marked by transverse spicules, some of which extended entirely across the marrow cavity. Vessels occasionally pierced the central portion of the growth line from the epiphyseal body and aided in restoring function to the growth center. When the injection of emboli was made such that a bony epiphysis was infarcted with its corresponding metaphysis, there was complete necrosis of the conjugal epiphyseal cartilage and a tendency for it to be narrower than usual and collapsed. This was most marked in the epiphyseal cartilage line of the head of the femur where the force of weight bearing caused the head to droop and to overhang the neck. Impaired nutrition and growth produced shortage of the neck and its angle with the shaft was more acute than normal.

The primary site of embolic infarction of the femoral epiphyses was beneath the articular or other cartilage and was similar to metaphyseal infarcts beneath epiphyseal lines of the diaphysis. Such infarcts of the head of the femur were usually accompanied by regions of necrosis in the corresponding acetabula and haversian fat tissues at the base of the ligamentum teres.

Necrosis in the femurs produced by carbon emboli was more marked and extensive in the medullary tissues of the shaft than after the injection of clumps of dead cocci. There were

less definite deposits of the material beneath the columns of ossifying epiphyseal cartilage and more occlusion of larger vessels due to the greater size of the carbon particles. Revascularization and organization of the charcoal infarcted tissues required a longer time and the ultimate fibrous tissue replacement was more dense. The killed organisms produced more profound changes in the growth centers and seemed to elicit greater necrotic bone destruction by giant cells (osteoclasts) than the charcoal emboli.

Agglutinated suspensions of living Staphylococcus aureus. The gross alteration in size and contour of femurs infarcted with living were similar to but more marked than in those that received injections of killed organisms. In addition several joints contiguous to infarcted metaphyses contained exudate from which a pure culture of the organism was obtained. Some of these joints at the distal end of the femur were associated with liquefaction necrosis of the metaphysis and pathological fracture through the epiphyseal cartilage plate. There were no abscesses of the soft tissues.

Microscopic examination demonstrated anemic necrosis according to the pattern described for bland infarction combined with exudative inflammation. The latter agent intensified the hemorrhages and necrosis and elicited a marked infiltration of polynuclear leucocytes about the septic infarct. This acute pyogenic osteomyelitis very definitely and constantly began in the so called growth regions with a few small foci in the inner layers of the cortex. In preparations of recent infarcts there were masses of cocci wedged to the apices of the lacunar spaces between strands of calcified cartilage matrix. These collections were present also beneath articular and other cartilage of infarcted epiphyses and occasionally within the haversian canals of the cortex, but not in the medullary tissues of the shaft. The intimate association of the site of beginning abscess formation with the very tips of the spaces between ossifying strands of calcified cartilage matrix was striking. Partial or complete separation regularly occurred within the epiphyseal cartilage plate at the base of the metaphyseal

infarcts. The line of separation in histological preparations was straight and uniform. Its position corresponded to the limits of cartilage necrosis and to the line demarcating the extent of necrosis in epiphyseal plates at the base of infarcts produced by bland bacterial emboli. That portion (about 80 per cent of the width of the plate) remaining attached to the bony epiphysis usually maintained its viability except when the epiphysis was infarcted with the metaphysis. There often was a narrow localized zone of tissue reaction on the epiphyseal side of the cartilage plate after septic infarction of the growth center but this was slight compared to the reaction on the metaphyseal side of the conjugal cartilage.

When the metaphyseal abscesses were sufficiently large to extend to the cortex there was exudate in the canaliculi of the bone and occasionally beneath the periosteum. Necrosis of the subperiosteal tissues elicited a marked cellular and fibrous tissue reaction of the periosteum, dead bone absorption and new bone formation. Complete separation of the epiphysis occurred when the walling-off process here at the periphery of the cartilage plate was unable to maintain viable tissues between epiphysis and diaphysis. The amount of new bone formation (involucrum) about the infarcted portion of the shaft depended upon the amount of damage to the cortex and it varied from none to a wide layer. Occasionally the periosteum also was necrotic, in which event no involucrum formed and consequently the metaphyseal portion of the shaft collapsed.

The walling-off and reorganization process in septic infarcts seemed to proceed more slowly than those produced by bland staphylococcus emboli. Septic necrosis produced more new cortical and spongy bone, greater injury to the epiphyseal plates, and more disarrangement of the medullary tissues of the metaphyses than did the aseptic infarcts. In a few bones there were circumscribed regions of necrosis like encapsulated abscesses and with the return of growth activity in the corresponding cartilage line, these were pushed farther away from the epiphyses. The new bone formed outside infarcts of the endosteal

tissues was always well delimited from the dead cortical bone by cellular fibrous tissues containing osteoclastic giant cells, but sequestration was not observed.

EVALUATION OF EXPERIMENTS

The intra arterial injection of acid killed and agglutinated staphylococci through nutrient vessels of the femur in growing rabbits has demonstrated that infarcts and subsequent changes of bone can be produced by bland bacterial emboli. These infarcts resemble those produced by a particulate suspension of charcoal and probably no chemical factor from disintegrating bacteria is added to the embolic disturbance of circulation. The clumps of cocci were considerably smaller than the individual carbon particles and fewer particulate bacterial masses were injected. For this reason and because the bacteria were more readily removed from the tissues than the carbon the infarcts were smaller they stimulated less tissue reaction and healed more rapidly. Where the emboli contained living bacteria certain changes were noted which relate to septic and aseptic diseases of bone.

The wedge shaped regions of necrosis were intimately associated with so called growth centers because of the peculiar vascular arrangement and blood supply of subchondral tissues. The localization of the infarcts and collections of living staphylococci between the strands of calcified epiphyseal cartilage demonstrate that this is the site of lodgement of embolic material. Killed organisms were not demonstrated directly beneath the ossifying cartilage because the bacteria were small in number and rapidly disintegrated in the tissues. Carbon particles did not reach these tissues as a rule because they were too large for the caliber of the vessels. The terminal capillaries in the finger-like tissue spaces of the metaphyses, which erode the epiphyseal cartilage matrix in the process of growth probably are not loops but rather are thin walled tubes which elongate as the erosion of cartilage progresses. The absence of abscesses in the soft tissues, even when living agglutinated bacteria were injected into the deep femoral artery supports this belief. Appar-

ently the clumps were sufficiently small to pass through the usual capillary bed. Necrosis beneath ossifying cartilage and epiphyseal separation even when the cocci were not agglutinated also favor a distinctive capillary pattern in the growth centers. This capillary arrangement is present beneath all cartilage of the epiphyses but the number of actively proliferating vessels is probably dependent upon the amount of bone formation. Since growth in length occurs in the metaphyses, these tissues are more vulnerable than the subchondral tissues of the epiphyses where growth is by expansion. Following embolic occlusion of the capillaries there was retrograde thrombosis the extent of which depended upon the size and number of particles injected and the collateral circulation. The tissue changes with infection added to this vascular disturbance by mycotic emboli depended upon the virulence and mass of living organisms. Therefore it is possible clinically to have all stages between anemic infarcts and acute abscesses from bacterial emboli either pyogenic or specific as tuberculosis.

The tissues in the center of the metaphyses were more vulnerable than those beneath the periphery of the epiphyseal cartilage plates because the latter have a periosteal blood supply. This was demonstrated by regular occurrence of small infarcts beneath the center of the epiphyseal cartilage and by ingrowth of blood vessels and reaction tissues from the peripheral portions of the metaphysis and from the periosteum. Further necrosis of the metaphyseal ends of the epiphyseal cartilage columns and interference with ossification were not so marked near the cortex particularly in regions opposite the insertion of muscles and tendons. Infarcts at the distal end of the femur tended to be slightly above the center of the plate since the articular cartilage extends far up the bone anteriorly and the periosteum has no muscle attachments. Complete separation in the epiphyseal line occurred only when the region of necrosis included the cortical and periosteal tissues of the metaphysis.

Assuming that periosteal collateral circulation to metaphyses is a constant or uniform

potential source of nutrition the vulnerability of a given growth center is proportionate to its size. For this reason metaphyseal infarcts septic or aseptic more often occur in large bones, such as the femur tibia and humerus and in these subjacent to the broad epiphyseal cartilage plates. Also other things being equal infarcts occur most commonly where there is greatest growth activity since it is here that compact strands of calcified matrix and the lacunar spaces between them are longest and have many developing capillaries that project into the eroded cartilage. Subchondral foci of infection and bland infarcts may occur in the epiphyses after the epiphyseal lines are completely ossified so long as there is enchondral ossification in the secondary centers. The predominance of lesions in some over other small bones probably concerns individual differences in structure and blood supply. External trauma may localize an infection but only in so far as it disturbs the vascular pattern of a portion of bone or accentuates the dearth of collateral circulation in regions that are normally more susceptible to infection and nutritional disturbances.

The uniform occurrence of necrosis at the base of the infarcts in the metaphyseal ends of the columns of epiphyseal cartilage demonstrates that these tissues which are about to be converted into spongy bone and osteoid tissue have a diaphyseal blood supply and that there is no noteworthy vascular communication between the epiphyses and diaphysis. The amount of the necrosis in the cartilage plate was constant and marked the level where complete separation within the line occurred when the necrosis extended laterally to include the cortex and periosteum. Since the columns of cartilage continued to grow from above even after complete separation within the line cartilage proliferation is dependent upon epiphyseal blood supply and should be distinguished from ossification. Necrosis of the plate occurred only when its bony epiphysis was infarcted. A collateral circulation to the metaphyses from the epiphyses through the conjugal cartilage was formed in some of the infarcted metaphyses. Occasionally after marked infarction of the metaphysis the distal end of the femur had a club-shaped

deformity due to the relative expansile overgrowth of the knee epiphysis.

Bland infarcts and abscesses localized also beneath the endosteum and within cortical bone. This suggests that the capillary arrangement among spicules of spongy bone and within Haversian system to some degree may be similar to the vascular pattern described for enchondral ossifying tissues. However the extent of involvement of the cortex opposite an infarct of the metaphysis was not constant as if limited, and it seemed to be dependent upon the size of the infarct. Septic infarcts extended along the epiphyseal cartilage plate and included considerably more compact bone than those produced by a similar injection of killed organisms. The bacteria from septic foci of necrosis penetrated the subperiosteal tissues and produced suppurative arthritis. The retrograde extension of osteomyelitis from the metaphysis to the more central portions of the shaft was considerably less than its spread laterally due to the abundant blood supply of the central medullary tissues. Some of the abscesses of longer duration were farther from the epiphyseal lines because of reorganization and return of function to the growth centers. Involucrum formation seemed to be stimulated by the presence of necrotic compact bone and was present only where the necrosis had not included the periosteum. This was similar to new bone formation by the periosteum observed after infarction of the femur with charcoal emboli (18). The removal of dead bone by osteoclastic giant cells seemed considerably more active in infarcts produced by staphylococci living or dead than in those caused by charcoal emboli.

Deformity results when a portion of a bone is unable to withstand the stresses placed upon it. The alteration in contour depends upon the amount of injury to normal structure present within the bone and to the forces which tend to produce distortion. The type and virulence of bacteria when present in foci of necrosis are important in determining the amount and acuteness of the disease and subsequent deformity. Bacterial infarction of the proximal end of the femur produced various degrees of collapse and hypoplasia of the

neck (coxa vara) and the neck rotated anteriorly so that the entire femur was displaced inward slightly. Infarcts in the head of the femur caused this epiphysis to flatten and overhang the neck at its shelving edge. Femurs infarcted for 3 weeks or more partially regained the growth deficiency either by hyperplasia in an unaffected growth center or organization and resumption of function of the infarcted metaphysis.

Transverse spicules of bone often were observed in infarcted metaphyses after organization and return of function to the growth centers. These marked the level of the ends of epiphyseal cartilage columns at the time of infarction and they correspond to the so-called lines of arrested growth described by many authors (6, 14, 25) in various acute illnesses and metabolic disturbances.

SUMMARY

Masses of bacteria living or dead may act as emboli in producing septic or aseptic infarcts in bone. The subsequent changes are modified by infection when the infarcts are produced by infected emboli.

These infarcts occur regularly beneath ossifying cartilage especially in the metaphyses due to relative poor collateral circulation in subchondral tissues and to the presence of open end-capillaries immediately beneath ossifying columns of cartilage. The occurrence of foci in some metaphyses more than in others probably is dependent upon the diameter of the epiphyseal cartilage plate and the rate of bone growth within the metaphysis.

The extent of bone destruction and subsequent distortion depends upon size of the infarct and if infected further upon the mass and virulence of the bacteria. Exudative arthritis may follow the spread of a metaphyseal focus of infection along the epiphyseal line to the periosteum.

Metaphyseal growth centers and the adjacent portion of epiphyseal cartilages obtain their blood supply from the periosteum and nutrient vessels of the shaft. The epiphyseal portion of the cartilage plates, about four fifths of the thickness depends upon the circulation of the epiphysis. Separation of

epiphysis and diaphysis occurs along a plane between the limits of the two sources of nutrition within the conjugal cartilage plate.

The stimulus of necrotic cortical bone and adequate periosteal blood supply are necessary for the formation of new compact bone (involucrum).

Lines of arrested growth may be present in metaphyseal infarcts produced by clumps of living or dead staphylococcus aureus.

BIBLIOGRAPHY

1. AUCHINCLOSS, G. Ueber ausserliche Infarkte des Knochensystems und ihre Bedeutung fuer die Lehre von den primären Epiphyse-osteosen. *Arch. f. klin. Chir.* 1918, 151, 71.
2. Idem. Knochennekrose und Sequenzbildung. *Deutsche med. Wochenschr.* 1914, 40, 1.
3. BOWMAN, H. R. Experiments with foreign materials in the region of the epiphyseal cartilage plate of growing bones to increase their longitudinal growth. *J. Bone & Joint Surg.* 1930, 11, 365.
4. COMBES, E. L. Staphylococcus viridans osteomyelitis. *J. Bone & Joint Surg.* 1934, 14, 244.
5. ELIASOV, F. L. and FINKELSON, L. K. Epiphyseal separation of the long bones. *Surg. Gynec. & Obst.* 1934, 58, 61.
6. ELLIS, A. L., SOUTHERN, S. F. and PARK, E. A. Transverse lines in X-ray plates of the long bones of children. *Johns Hopkins Hosp. Bull.* 1927, 41, 362.
7. GREENWOOD, H. H. Relation of tuberculous to Kochler's disease. *Brit. J. Surg.* 1927, 15, 245.
8. HAAS, S. L. The relation of the blood supply to the longitudinal growth of bone. *Am. J. Orthop. Surg.* 1917, 15, 137.
9. Idem. The localization of the growing point in the epiphyseal cartilage plate of bones. *Am. J. Orthop. Surg.* 1917, 15, 503.
10. HALLERMAN, K. O. Acute osteomyelitis. *Surg. Gynec. & Obst.* 1934, 59, 35.
11. HALLERMAN, W. Ueber die Beziehungen zwischen Osteoporose und arterio-sclerotischen Veränderungen der erkrankenden Knochengewebe am oberen Femurende. *Arch. f. klin. Chir.* 1923, 120, 683.
12. HARRIS, M. and ZOLLINGER, R. Osteochondritis of the growth centers. *Surg. Gynec. & Obst.* 1934, 57, 145.
13. HARRIS, H. A. The vascular supply of bone, with special reference to the epiphyseal cartilage. *J. Anat.* 1929, 64, 3.
14. Idem. Lines of arrested growth in the long bones in childhood. The correlation of histological and radiographic appearances in clinical and experimental conditions. *Brit. J. Radiol.* 1931, 4, 561.
15. JACKSON, L. Experimental streptococcal arthritis in rabbits. *J. Infect. Dis.* 1913, 12, 364.
16. JAEGER, P. Beiträge zur Kenntnis der histologischen Vorgänge bei der Wachstumsbehinderung der Röhrenknochen durch Verletzungen des Intermediärknorpels. Morphologische Arbeiten von Schwabe. 1892, 1, 241. (Quoted from Haas.)
17. KIRKLAND, G. H. Sequences of experimental infarction of the femur in rabbits. *Arch. Surg.* 1934, 59, 519.

KISTLER EXPERIMENTAL BACTERIAL INFARCTION OF THE FEMUR 925

18. Idem. Formation of bone by the periosteum after experimental infarction by embolism of femur in rabbits. *Proc. Soc. Exper. Biol. & Med.* 1934. 31 1918.
19. KOTOMY A. The architecture and blood supply of the head and neck of the femur and their importance in the pathology of fractures of the neck. *J. Bone & Joint Surg.* 1935 7 575
20. KORMOS, F. Ueber freie Koeper in den Gelenken. *Deutsche Ztschr. f. Chir.* 1887 27 90
21. KUWABATA, H. Neue experimentelle Untersuchungen ueber die Entstehung der akuten eitrigen Osteomyelitis. *Deutsche Ztschr. f. Chir.* 1930 222 374
22. LUDWIG, E. Die Entstehung entzündlicher Knochenherde und ihre Beziehung zu den Arterienverwundungen der Knochen. *Arch. f. klin. Chir.* 1903 71 1
23. LUDWIG, E. and KULIGA, P. Untersuchungen ueber Knochenarterien. Mittels Roentgenaufnahmen innerer Knochen und ihre Bedeutung fuer einzelne pathologische Vorgaenge am Knochensysteme. Vol. 8. Berlin. A. Hirschwald, 1904
24. MEYERBRUCH, R. O. A consideration of the chemical and mechanical stimulation of bone with reference to the epiphyseal and diaphyseal lines. results of animal experimentation. *Am. J. Orthop. Surg.* 1910, 8 28
25. MILLER, L. F. and RUBELL, I. Transverse bands in the bones of a tuberculous child. *Am. J. Dis. Child.* 1934. 47 354
26. MUELLER, W. *Deutsche Ztschr. f. Chir.* 1887 Vol. 25
27. OBERMEYER, J. Formazione di necrosi circoscritte e di sequestrati nella tubercolosi ossea. *Chir. d'organi e di movimento*, 1933 18 317
28. PRANK, C. N. The relation of streptococcus viridans to apophysitis of the tibial tubercle. *Am. J. Surg.* 1934, 24 149
29. PRUMSTER, D. B. Newer knowledge of pyogenic infections of bone. *Proc. Inst. Med. Chicago* 1909 7 169
30. Idem. Repair of bone in presence of aseptic necrosis resulting from fractures, transplantations, and vascular obstruction. *J. Bone & Joint Surg.* 1930 12 769
31. Idem. Silent foci of localized osteomyelitis. *J. Am. M. Ass.* 1924, 82 1311
32. Idem. Chronic fibrous osteomyelitis. *Ann. Surg.* 1929, 90 736
33. PRUMSTER, D. B., BRUNSWIG, A., and DAY, L. Streptococcus infections of the epiphyses and short bones, and their relation to Legg Perthes disease, Klenboeck's disease and Koehler's disease of the tarsal navicular. *J. Am. M. Ass.* 1930 95 995
34. REUSCHAUER, F. Trauma und haematogene Knocheninfektion. *Beitr. z. klin. Chir.* 1932 156 411
35. SCHULTZ, W. Ueber die Ursachen der Bakterienabsgerung im Knochen. *Arch. f. klin. Chir.* 1933 177 450
36. SEW, N. Principles of Surgery 4th ed. p. 278 Philadelphia. F. A. Davis Co. 1909
37. SEVER, J. W. Changes in the epiphyses—secondary to infection. *New England J. Med.* 1933 209 63
38. STARR, C. L. Acute hematogenous osteomyelitis. *Arch. Surg.* 1922 4 567
39. VOOR, P. Die traumatische Epiphysentrennung und deren Einfluss auf das Laengewachstum der Roehrenknochen. *Arch. f. klin. Chir.* 1878, 22 343
40. WAGGLEY, C. P. G. Acute osteomyelitis in children. *Brit. M. J.* 1933, 2 752
41. WARDLE, E. N. The etiology and treatment of slipped epiphysis of the head of the femur. *Brit. J. Surg.* 1933 21 313
42. WILKINSON, A. O. The mechanism of acute bacterial infection of a joint. *Arch. Surg.* 1926 13 895

SYMPHETECTOMY AS A PRELIMINARY TO THE OBLITERATION OF POPLITFAI ANEURISMS

WITH A SUGGESTION AS TO SYMPHETIC BLOCK IN CASES OF LIGATURE, SUTURE, OR
THROMBOSIS OF LARGE ARTERIES¹

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THE incidence of extensive gangrene requiring amputation following operations for the relief of popliteal aneurisms is estimated by the writer to rest between 8 and 15 per cent. This approximation takes into consideration a probable number of unsuccessful cases which are not reported in the literature and for this reason the figure is higher than that obtained by Professor Matas (6) who found among 154 personal and reported cases of popliteal aneurism operated upon by his three methods of aneurismorrhaphy up to 1915 8 cases of gangrene or 5.2 per cent.

Doctor Matas' personal success has been extraordinary and the papers indicate that in his own cases he has had practically no gangrene. This splendid achievement has been obtained first by the use of his compressor (4) and tests for determining the adequacy of the collateral circulation (5) second by a correct clinical judgment as to the type of aneurismorrhaphy indicated, and finally by strict adherence to the principles of his operations (3).

Nevertheless, if others share my feeling they approach the obliteration of a popliteal aneurism with misgivings and will be grateful for any and which may provide further assurance that the collateral circulation will be adequate. Twice in cases of my own I have observed the development of a false aneurism during the preparatory 2 or 3 weeks of repeated compression of the femoral artery above the sac by Matas method. In neither instance was any direct pressure exerted upon the sac itself and I do not believe that the false aneurisms arose because of instrumental damage to the walls of the true sacs. The presence of an enlarging false aneurism causes compression of the motor and sensory nerve fibers, increases the discomfort of the patient, hurries the operator to carry out his procedure before the time he would otherwise elect, and

increases the likelihood of infection in the field either before or after the operation, or both. An advantage would be gained if an obliteration could be done safely at any time after admission to the hospital even almost immediately if indicated.

In the first case of which I speak the collateral circulation as tested by the method of Matas was doubtfully satisfactory. The dorsalis pedis and posterior tibial arteries were palpable but were weaker on the side of the aneurism. A sympathetomy was considered but was not carried out. Immediately after the obliteration of the sac the appearance of the toes and foot was discouraging and the outcome in brief was a mid thigh amputation necessitated by gangrene.

In order to avoid a possible repetition of this unfavorable result it was determined in the second patient to take advantage of the work of Mulvihill and Harvey who showed by well controlled experiments on dogs the tremendous advantage to be gained in the immediate postoperative period if a sympathetomy is done at the time of the ligation of the external iliac artery. When the sympathetomy was not carried out the subcutaneous temperature of the corresponding foot dropped gradually over a period of 2 to 7 hours to or almost to room temperature remained there for from 2 to 6 hours then gradually rose to body temperature on an average of 13 hours after the ligation of the external iliac artery. On the other hand when the sympathetomy had been performed the drop in temperature did not occur. Sympathetomy prevented, therefore, an 8 to 14 hour period of partial ischaemia. It is assumed that these experiments on dogs may be applied directly to the popliteal artery of man and there appears to be no reason to doubt the correctness of this view. Such ischaemia if applied to an already diseased

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human leg could hardly fail to be damaging or disastrous. Sympathectomy, on the other hand, should provide a wide margin of safety.

A short summary of the pertinent findings in the record of the second patient follows:

W. R. (L. C. H. No. 35926), a single colored dishwasher aged 20 years, was admitted on June 1, 1934. He first noted a swelling in the right popliteal space 2 months before. This rapidly enlarged causing him to limp because of inability to extend the knee joint completely. Pain, extending down the leg, began 2 weeks before admission. He had had a penile sore several years previously but had not been treated by incisions or injections. There was no history of trauma to the popliteal space. The patient had been troubled all his life by frequent slight nausea and copious, effortless regurgitation of food. These symptoms had not been relieved by the removal of his appendix 10 years previously.

Examination showed normal development and slight undernourishment. The pupils and eye grounds were normal. There was no periorbital edema. The nasal septum. The teeth were carious, the gums infected. Fluoroscopic examination and barium studies revealed a thoracic stomach which extended from the upper aperture of the thorax to the level of the diaphragm, where, after some delay the barium emptied directly into the small bowel. The balance of the intestinal tract appeared normal. The heart was slightly enlarged and an electrocardiogram showed borderline right axis deviation and sinus arrhythmia. The radial pulses were equal, strong, regular without sclerosis, rate 88. Blood pressure registered 120/80. There was an old lower right rectus operative scar. The knee jerks were present and approximately equal on the two sides.

In the right popliteal space was a large, tense, expansile pulsating tumor over which in certain positions of the limb a delicate thrill could be felt. A loud bruit with systolic accentuation was heard over the entire tumor. The skin and deep fascia were tense over the mass, the borders of which could not be made out. The knee, leg and foot were moderately swollen and the veins below the level of the tumor were engorged. Elevation only partly emptied them. There was moderate pitting edema of the extremity on the side of the aneurism. The feet and legs were moist and equally warm to touch. Flexion and extension of the knee were limited by painful tension in the region of the mass and by pain shooting down the leg. The dorsalis pedis and posterior tibial arteries were unusually easy to palpate on the left but on the right no pulsations could be felt. The dorsalis pedis artery on the right stood out as a pulseless cord. The femoral artery by pressure did not change the heart rate. Obliteration of this vessel stopped the expansile pulsation thrill and bruit in the popliteal

mass and on elevation of the leg during compression the mass became soft and plastic. The appearance of the knee suggested fluid in the joint but the patella did not float. There were no gross sensory changes in either leg but there was weakness of the anterior tibial and peroneal groups of muscles on the right. Injection of neoskiodan into the femoral artery produced an imperfect visualization of an almost spherical mass 6 centimeters in diameter in the midpopliteal region. No collaterals were seen.

The Matas test, carried out with a mechanical constrictor and an Eschmarch bandage showed no turn of blood to the subungual capillaries in from 2 to 5 minutes after removal of the bandage. Observation of the descending flush, however, was difficult to make in the presence of the black skin and cult to make in the presence of the black skin and further we were unable to be absolutely sure that some blood was not occasionally leaking past the constrictor. The veins did not fill well from below and my impression was, on the whole, that we were dealing with an unsatisfactory collateral circulation.

The blood Wassermann reaction was four plus. The blood hemoglobin (T) 80 per cent, red blood cells, 4,050,000, differential count and cent white blood cells, 7,750. The urine showed one plus albumin and an occasional pus cell. Analysis of the fluid obtained from the thoracic stomach by a nasal tube with its tip 32 centimeters from the nostril showed a specific gravity of 1.032, free hydrochloric acid 28 and total acid 46.

The temperature varied from subnormal to 100 degrees F. with a pulse of 80 to 100. Compression of the femoral artery just above the adductor hiatus was carried out for 5 to 10 minutes every 2 hours each day. Shortly the patient began to complain of increased pain in the knee and leg and the tumor and all of the tissues of the knee and leg enlarged. The knee was held flexed to 100 degrees for comfort.

On June 9, 1934, a right lumbar sympathectomy was performed under spinal anesthesia, severing the ram and removing the ganglia and trunk between the levels of the second lumbar and the first sacral vertebrae. A warm dry leg resulted which in contrast to the left, was hyperemic and exhibited a diffuse dusky red blush throughout. The slight fever persisted and the pain became more constant as the popliteal swelling increased in tenseness. The Matas test was now more difficult to carry out on account of the pain and because of the necessity of flexion but there was no longer any doubt as to the adequacy of the collateral circulation. After removal of the Eschmarch bandage there was always a return of color to the sole of the foot and to the tissues beneath the nails within one minute and a half. No pulsation returned to the dorsalis pedis and posterior tibial arteries. The weakness of the anterior tibial and peroneal muscles became a total paralysis with marked hypaesthesia of the deep and superficial peroneal areas.

On July 5, 1934, an obliterative endoaneurismorrhaphy was carried out under spinal anesthesia. A

curved longitudinal incision, convex medially was made over the popliteal space. The semitendinosus muscle was found thinned out and displaced. No nerve trunks, large veins, or lymph nodes were exposed. The deep fascia was incised over about 8 centimeters of the aneurismal surface, which was discolored with blood pigment and somewhat edematous. The circulation was temporarily occluded by a blood pressure cuff which had been placed around the upper thigh. The sac when opened longitudinally was found to be 3 millimeters thick, and contained fresh and old blood clots as large as one and one half adult fists. The posterior surfaces of the femur and tibia were palpated but there was no break through to the bone or joint space. The endothelium was intact about the upper and lower orifices and along the external side of the sac, but elsewhere the lining was shaggy and false and extended upward and downward irregularly between the muscular layers. Closure of the upper and lower orifices was accomplished with fine interrupted silk sutures. On removal of the pressure from the femoral artery above, there was only slight oozing. One geniculate vessel was closed from the inside and the large sac was obliterated with three layers of interrupted silk sutures. The deep and superficial fascia was closed with interrupted silk without drainage. A loose bandage and posterior plaster splint were applied and the patient was returned to bed with the leg slightly below the level of the heart and with a warm cradle over the extremities.

From the first there was no doubt as to the adequacy of the circulation. Color returned to the nails almost immediately after release of compression and the return was as rapid or slightly more rapid than on the opposite side. Forty-eight hours after operation there could be felt and seen a pulsating artery beneath the skin on the anteromedial surface of the knee. The dorsalis pedis and posterior tibial vessels on the right remained pulseless. The slight fever and the peroneal paralysis persisted and the deep tissues beneath the cleanly healed external wound gradually became more swollen. On the nineteenth day after operation a soft, deep, indolent abscess was opened, and about 200 cubic centimeters of odorless, *Staphylococcus aureus* pus was evacuated. Thereupon the temperature returned to a consistent normal for the first time since admission and the wound healed rapidly. The motor paralysis was still present on discharge on July 31, 1934.

Had it not been that due to the enlarging false aneurism and the pain the sac must be obliterated promptly I should have been tempted to await the arrival of the Pavax apparatus (2) which Doctors Mont Reid and Louis Hermann have so kindly sent us from Cincinnati for use in the vascular clinic and I would feel more enthusiasm in reporting the evident benefit of preliminary sympathetec-

tomy in this case, were it not for the fact that the procedure will without doubt shortly be superseded by the use of their effective stimulant of collateral circulation. By its use the diameter of the collateral arteries can not only be increased before operation but the entire limb may be placed in the boot under negative pressure immediately after operation, in this way counteracting the tendency toward sympathetic overaction in a limb recently traumatized. In fact the limb will be subjected to the negative pressure before the passive dilatation due to the spinal anesthetic, if such be used, has worn off so that the precious collaterals may never be subjected to the action of the sympathetic fibers until the period of jeopardy is passed. It is true of course that during the period before this apparatus becomes generally available the procedure of sympathetectomy or sympathetic block, may be of use in the cases under consideration and also in the management of other aneurisms and tumors which involve large arteries of the extremities (1).¹

A further suggestion may be made. It is probable that a temporary block of the appropriate portions of the sympathetic chain with alcohol will continue to be valuable in those cases in which because of the presence of fracture apparatus or dressings, the Pavax apparatus cannot be utilized. I have in mind especially serious fractures or injuries because of which it is found necessary to suture or tie the large arteries or those cases in which there is present arterial thrombosis which plays a devastating part.

SUMMARY

Lumbar ganglionectomy was performed as a preliminary to the obliteration of a popliteal aneurism thereby avoiding the constrictor action of the sympathetic fibers on the collateral arteries during the dangerous early postoperative period.

In the same way advantage should be derived from sympathetec ganglionectomy or sympathetic block carried out before or immediately after operations or injuries which

The preliminary sympathetecomy reported in another of the sympathetic block previously found to have been reported by Gage in the operative management of cases of syphilitic aneurism of the common iliac artery.

involve obstruction or threatened obstruction to large arteries of the extremities

The rationale for these procedures is contained in the work of Mulvihill and Harvey.

In suitable cases the pavaex apparatus of Herrmann and Reid should accomplish the same result without interference with the sympathetic fibers themselves

REFERENCES

- 1 GAGE, MIMS Mycotic aneurysm of the common iliac artery sympathetic ganglion block as an aid in the development of the collateral circulation in arterial aneurysm of peripheral arteries report of a case *Am J Surg* 1934, 24 667-710
- 2 HERRMANN J C and REID M R Pavaex (passive vascular exercise) treatment of obliterative arterial diseases of extremities *J Med* 1933 14 524-529
- 3 MATAS, RUDOLPH An operation for the radical cure of aneurysm based upon arterorrhaphy *Ann Surg* 1903 37 161-196
- 4 Idem Tests to determine efficiency of collateral circulation before attempting permanent occlusion of great surgical arteries *Ann Surg* 1910 52 126-130
- 5 Idem Testing the efficiency of the collateral circulation as a preliminary to the occlusion of the great surgical arteries *J Am M Ass* 1914, 63 1441-1447
- 6 Idem Endo-aneurismorrhaphy *Surg Gynec & Obst* 1920, 30 456-459
- 7 MULVIHILL, D A and HARVEY S C Studies on collateral circulation I Thermic changes after arterial ligation and ganglionectomy *J Clin Invest* 1931 10 423-429

OBSTRUCTIVE LESIONS OF THE UTERUS AND THEIR COMPLICATIONS¹

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A REALIZATION that cervical strictures are of clinical importance was impressed upon me very gradually in incidental to interest in the pathology of chronic leucorrhoea. A survey of my records reveals frequent notations of cervical strictures as early as 1920. Yet I did not awaken to an appreciation of their true significance until some years later.

In 1929 at the inaugural meeting of the Baltimore Obstetrical and Gynecological Society I discussed the incidence and clinical importance of cervical obstructions.² To the best of my knowledge these lesions, other than complete stenosis, and hydrometra and pyometra incident to cancer and to radium therapy, had previously been recognized only as pathological curiosities, and there is apparently still a tendency to overlook their rôle in the etiology of pelvic disturbances.

It is scarcely necessary to emphasize that the impassable cervical canal of many children means a distinct physiological

The frequency of obstructions of the cervix should again be emphasized they are very common indeed. But my chief aim at this time is a presentation of important pathological changes which are encountered in the more serious cases, in the hope of arousing greater interest in this subject.

CASE 1. V. B. aged 51 years, with a history of a normal menopause at 48 years, suddenly developed a profuse purulent leucorrhoea 1 month prior to entrance into the hospital. Aside from having given birth to three healthy children after normal labors, the previous obstetrical and gynecological history was negative. There had been no instrumentation or infection to account for the sudden appearance of the purulent discharge.

Attempted dilation under anaesthesia revealed a canal so firmly strictured that the obstruction could not be overcome, and a vaginal hysterectomy was resorted to. The uterus, opened by anterior incision after removal, had a constricted granular canal with multiple firm osseous bands and pocketed chambers containing purulent material above the various sites of obstruction.

This case with multiple strictures and pocketings of the uterus of unknown etiology complicated by infection of the retained secretion eventuating in postmenopausal profuse purulent leucorrhoea, exemplifies the pathology which is often responsible for senile vaginitis. With cessation of the menstrual function and shrinkage of the cervical lumen lesser lesions of varied etiology which cause no annoyance in earlier years suffice to make complete obstruction. There is first a retention of mucoid secretion then contamination of the retained material and finally a pyometra, or more commonly a seepage through of the purulent accumulation when pressure sufficient to overcome the obstruction has developed within the uterine cavity. A spontaneous cure may result but dilation or more extensive surgery is usually required.

CASE 2. E. B. aged 67 years, married 43 years, entered Passavant Memorial Hospital July 23, 1934. She had one child, at the age of 35 years, after a diffi-

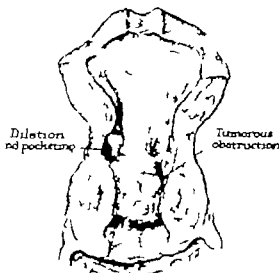


Fig. 1. Case 2. Non-malignant, tumorous obstruction of endocervix with dilation and pocketing above on right. The uterine musculature was soft and senile, and friable almost to the point of rupture in the pocketed region. (Two-thirds actual size.)

¹ Presented before the New York Obstetrical Society, January 8, 1935, and before the Society of Gynecology of New Jersey, January 6, 1935. From the Department of Obstetrics and Gynecology, Northwestern University Medical School and Passavant Memorial Hospital, Chicago.

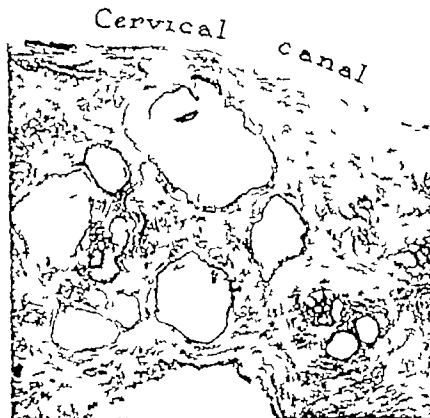


Fig. 2 Case 2. Low power photomicrograph of endocervical tumefaction, consisting of a stroma honeycombed with a multitude of glands and cystic gland spaces. $\times 9\frac{1}{2}$

cult spontaneous labor with normal recovery. Menstruation, always normal, had ceased suddenly at the age of 50.

The patient complained of a watery leucorrhoeal discharge of many years' duration sufficient to require a pad. Occasional slight dark bloody spotting had been present for 3 years; a profuse gush of thin dark fluid occurred 3 days before entrance. Examination revealed a large cystocele and a slight amount of dark brown discharge from the uterus, which was of generous size and descended nearly to the vulvar orifice. The cervix was considerably lacerated; the perineum relaxed.

Operation. Dilation, accomplished without difficulty despite an obstruction in the upper cervix, was accompanied by passage of several cubic centimeters of mucoid and watery brown retained secretion. Curettage was abandoned because the uterine wall was found to be soft and thin, and perforation appeared imminent. The prolapsed uterus was then removed vaginally, normal tubes and ovaries were palpated, the cystocele was corrected and the perineum repaired.

When the soft senile uterus, which was 4 inches in length, was opened, a tumefaction high in the endocervix was bisected. A similar nodulation, in size and appearance resembling the surface of a large preserved strawberry, was present on the posterior wall and terminated above at the level of the internal os of the greatly elongated cervix. The body of the

uterus had a capacious cavity, especially in the lower uterine segment, which was pocketed on the right; the uterine wall was soft and senile, thin, and friable almost to the point of rupture in the pocketed region above the tumorous obstruction. Remaining traces of accumulated dark fluid were still present here. In the wall of the fundus were a few small fibroids, one protruding into the cavity (Fig. 1).

Microscopic examination revealed the tumefaction of the endocervix to be a non-malignant growth, consisting of a stroma honeycombed with a multitude of glands and cystic gland spaces of varied size up to many millimeters in diameter. Active pro-



Fig. 3 Case 2. High power photomicrograph of hyperplastic endocervical glands (see Fig. 2). $\times 125$

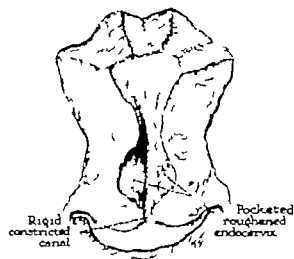


Fig. 4. Case 3. The external os was stomatous, the cervical canal for 2 centimeter above was narrowed and rigid, passing over suddenly into a sacculated endocervix, the wall of which was roughened and furrowed. (Two thirds actual size)

hyperplasia of the glands is apparent but there is no evidence of malignancy (Figs. 2, 3).

In this case there had developed without discoverable cause non-malignant tumorous nodulations in the endocervix characterized by glandular hyperplasia and multicystic degeneration with the production of partial obstruction of the uterus.

CASE 3. E. J. aged 44 years, married 21 years, entered Passavant Memorial Hospital July 23, 1934. There had been an appendectomy, a removal of both fallopian tubes and one ovary, and a resection of the other ovary, also a diagnostic curettage, in 1919 in St. Paul. The following year having moved to Chicago the patient was given local treatments for relief of persistent leucorrhoea. These treatments, administered at various times during 1920 included endocervical applications of tincture of iodine and of silver nitrate of varied strength. It is recorded also that the patient suffered from pelvic discomfort, and a semi-fluctuant mass was palpated in the region of the right broad ligament.

Ten years later in 1930 when I first saw this patient there was persistent pelvic pain, evidently from adhesions, and a fist sized soft mass was still present in the deep right pelvis. At the next visit in 1934, immediately before entrance into the hospital, marked pelvic distress was still present. The patient gave history of regular menstruation every 28 days of 4 days duration until the preceding year since which time the periods had become slightly irregular but continued to be normal in amount and

painless. Two months prior to entrance, immediately following a menstrual period, there had been a sudden gush of yellow fetid discharge. This was profuse for 1 or 2 days, followed by moderate irritating, dark watery discharge which persisted until entrance into the hospital.

Operation. The appendix, tubes, and ovaries were found to be absent except for a tarry mass in the right broad ligament in which were some remnants of ovarian tissue. Massive pelvic adhesions almost completely concealed a heavily dragging uterus, to the right of which was the broad ligament haemorrhagic accumulation just referred to. A complete abdominal hysterectomy was performed and the associated lesions were attended to.

The removed uterus was of generous size 3½ inches in length, the peritoneal surface studded with fibrous tags, the tubes absent. At the time of opening the uterus the external os was found to be stomatous, the cervical canal for 3½ centimeter above was narrow, granular and rigid, passing over suddenly into a sacculated space containing prune juice material. The endocervix in the sacculated region was rough and furrowed (Fig. 4).

Microscopic study of the pocketed rough endocervical wall above the structured region reveals extensive glandular hyperplasia, the columnar epithelium of the glands having undergone extensive metaplasia into squamous epithelium. In some regions the squamous epithelium is seen replacing the columnar cells. In other regions the process is complete and the squamous layer has attained massive thickness. There is a marked tendency to proliferation but no evidence of invasion (Figs. 5, 6).

In this case the stricture of the lower cervix is evidently ascribable in part to infection in part to instrumentation and local medication. Above the strictured incompletely obstructed lower cervix the epithelium of the pocketed and dilated endocervix subjected to the irritation of accumulated menstrual fluid and debris, has undergone marked leucoplasic metaplasia into squamous epithelium.

CASE 4. M. C. aged 27 years, unmarried, entered Passavant Memorial Hospital October 22, 1934. She had been seen 5 years previously when a tentative diagnosis was made of chronic appendicitis and early endometriosis. The uterus at that time was sharply anteverted. The patient then wandered elsewhere and the appendix was removed through a McBurney incision; the pelvis was not explored.

Upon her return to me the patient stated that for the past year there had been continuous pelvic discomfort. Menstruation was fairly regular of a gushing character, excruciatingly painful, occurred at intervals of 23 to 25 days and was of 7 days duration, muddy during the final days. There had been persistent dark brown menstrual flow for an entire month prior to entrance. For many months there

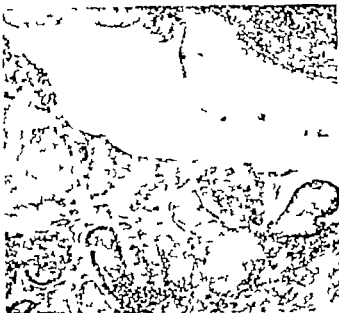


Fig 5 Case 3 Photomicrograph of endocervical wall above structure (see Fig 4) revealing leucoplasic metaplasia of columnar epithelium into squamous epithelium (The cavity in the illustration is a fold not the cervical canal) $\times 50$



Fig 6 Case 3 High power photomicrograph revealing squamous cell metaplasia of endocervix of uterus shown in Figure 4 $\times 90$

had also been a watery mucoid leucorrhoea associated with cramps, beginning a few days after menstruation and continuing for 3 or 4 days.

Examination revealed the uterus somewhat fixed and huddled in retrocession the fundus curled anteriorly as in congenital anteversion. Nodulations in the cul-de-sac and in the regions of the adnexa were pathognomonic of endometriosis.

At operation a textbook picture of extensive pelvic endometriosis was encountered. It was noted that the fundus of the retrocessed fixed uterus pointed anteriorly and certainly had never been retroflexed. Tarry cysts were present in both enlarged ovaries blueberry and raspberry nodules and endometriotic adhesions completed the picture (Fig 7).

The opened uterus had a rigid stomatous canal in the lowermost centimeter with a bell shaped endocervical pocket immediately above. The endometrium of the body of the uterus was succulent and numerous small polyps were present.

In this patient with extensive pelvic endometriosis and an upright uterus a cervical stricture had apparently produced dilation above and retrograde spilling of menstrual debris and was the probable cause of the endometriosis.

Microscopic study of the pocketed endocervix at a level of a centimeter and more above the external os reveals a surface covered with festoons of hyperplastic glands. In many areas the columnar epithelium of the glands is being replaced or has been replaced com-

pletely by squamous epithelium. The squamous layer often attains a considerable thickness but there is no evidence of invasion or other changes characteristic of malignancy (Figs 8 9 10).

The pocketed endocervix of this patient was undoubtedly bathed in retained secretion just as in Case 3. And again we find extensive squamous cell metaplasia. From these cases it would appear that the pocketed mucosa above cervical strictures is peculiarly predisposed to metaplasia and in this we find two features of special interest: (1) a possible source of the cells which give rise to squamous cell endocervical cancer and (2) an irritating retained secretion which may be a stimulant to cancerous growth. It should be emphasized that we have noted repeatedly the peculiarly irritating qualities of retained fluid which escapes into the vagina and bathes the vulva.

CASE 5 W. K. aged 38 years married 4 years, nulliparous, entered Passavant Memorial Hospital July 30 1934. Increasing pelvic discomfort and severe dysmenorrhea were the chief complaints. Menstruation was fairly regular but prolonged and characterized by premenstrual spotting for a week, followed by the passage of clots with establishment of the flow.

At operation the ovaries were found to be converted into tarry cysts the left containing approximately a liter of dark bloody fluid, the right one-fifth as much. The upright body of the uterus was of double normal size and contained multiple small fibroids.

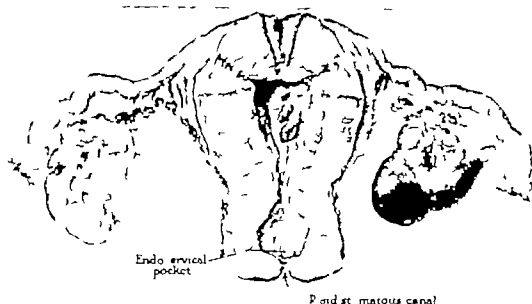


Fig. 7. Case 4. Pelvic endometriosis in a patient with an upright uterus, a cervical stricture, dilation above the stricture, squamous cell metaplasia of the endocervical columnar epithelium, and uterine polyp. Retained secretion above the stricture was probably a factor in producing the metaplasia; retrograde spillage of menstrual debris through the fallopian tubes may have caused the endometriosis. (Two-thirds actual size.)

The uterus was opened after removal and a granular endometrium was encountered. It was puckered but not definitely obstructed at the external os, and at the internal os was a rounded tumefaction similar to those found in Case 2, more than a centimeter in length with associated puckering of the indurated mucosa and distinct narrowing of the lumen.

It is to be noted in this case as in Case 4 that pelvic endometriosis developed despite the upright position of the uterus. And in conformity with my previous experience in patients with endometriosis and a well placed uterus interference with uterine drainage was again encountered, the obstruction in this case being a cystic tumorous thickening at the internal os.

Microscopic study of the tumorous area reveals fibrotic tissue honeycombed with innumerable glands and cystic glands (Fig. 11).

It would appear that tumorous obstructions of the cervix (see also Case 2) may be composed of hyperplastic glands and stroma. This tissue is not bathed in retained secretions and seemingly there is no tendency to metaplasia of its columnar epithelium.

CASE 6. R. S. aged 42 years, entered Passavant Memorial Hospital December 5, 1930. At the age of 29 years, the uterus had been dilated for relief of

sterility without result. There was no history of other instrumentation or of pelvic infection. Menstruation was normal and regular until 9 months before entrance, when it became excruciatingly painful and very profuse and of a brownish character much of the time.

Operation. Although there was a dark bloody discharge from the uterus, the cervical canal would not admit even the finest Hegar dilator. At abdominal hysterectomy the tubes and ovaries were found firmly plastered to the posterior surface of a uterus of double normal size which contained several small fibroids. The tubes were open at their fimbriated extremities.

Examination of the uterus after removal revealed cystic degeneration, stricturing and some pocketing throughout the length of the cervical canal, and stagnant dark liquid blood was present in the uterine cavity, evidently accumulated because of defective drainage.

In this patient without history or discoverable evidence of infection and no instrumentation other than dilation for sterility in her early married life, the etiology of the cystic degeneration and multiple firm strictures of the cervix is uncertain. Obstruction with backpressure of the retained secretion and retrograde menstruation rivals the more common infectious processes as the possible cause of the adhesions which held the patent tubes



Fig 8 Case 4. Low power photomicrograph of pocketed endocervix showing hyperplastic endocervical glands and metaplasia of columnar epithelium into squamous epithelium $\times 31$

and the ovaries to the posterior surface of the uterus

CASE 7. M. M. aged 38 years married 18 years entered Passavant Memorial Hospital September 30 1934. At the age of 22 years the patient had given birth to twins, delivered by forceps. A bilateral

thrombophlebitis developed in the puerperium and was persistently recurrent thereafter. When 27 years of age she had received a radium treatment, evidently an intracervical 2 hour 50 milligram application for a scar in the cervix. At the age of 32 years another child was born, a hard labor with bag insertion, followed by a recurrence of the thrombophlebitis



Fig 9 Case 4. Higher power photomicrograph of area of metaplastic epithelium which is also shown in Figure 8. $\times 95$



Fig 10 Case 4. Photomicrograph of endocervical epithelium under higher power (see Fig 8) showing deeply stained squamous cells replacing the columnar cells $\times 190$.

Cervical canal

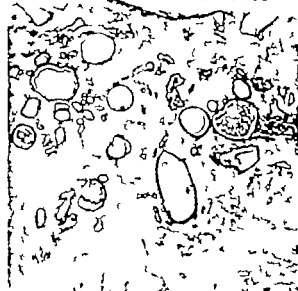


Fig. 1. Case 9. Low power photomicrograph of endocervix. Impaction consisting of a stroma honeycombed by an multitude of glands and cysts gland spaces (see also text) $\times 9$.

At the time the patient came to me again more or less under my care thereafter because of pelvic discomfort and lacerations. She was also attended by an internist because of intractable colitis and recurrent fever. Menstruation became irregular at the age of 36 years, 2 years before entrance into the hospital. For 6 months the flow had been very profuse, greatly prolonged, and accompanied by severe dysmenorrhea. A persistent, dark brown, tarry discharge was present in the intervals.

Surgery was finally resorted to not only because of bleeding and progressive increase in the size of the uterus but also with the hope that operation might help the colitis. At exploration a varicocele nearly the size of one's wrist was found in the left broad ligament, a mass of veins one third as large was present on the right, one of them distended with an old thrombus.

The removed uterus was more than twice normal size and measured 6 1/4 inches in length. The external cervix was badly lacerated and frayed. Bisection revealed that the higher endocervix had undergone extensive cystic degeneration, the cervical canal being reduced to an exceedingly narrow distorted channel, barely admitting a probe. The constricted canal of the cervix passed over abruptly into a spacious uterine cavity. The body of the uterus presented a diffuse adenomyosis with massive thickening of the wall throughout (Fig. 12).

In the dilated pocketed lowermost portion of the uterine cavity we again found extensive metaplasia (Fig. 13). A rugged columnar epithelium was well preserved in some areas, in others it was more or less com-

pletely replaced by squamous cell metaplasia which often attained a depth of numerous layers. In the deeper uterine wall in this region, as well as elsewhere, there was extensive adenomyosis.

From clinical observation of the progress of this case as well as from study of the pathology encountered I am led to believe that stricture of the cervix with backpressure of retained secretions and menstrual blood was the cause of the adenomyosis of the uterus as well as the squamous cell metaplasia of the endometrium.

CASE 8. M. M. aged 49 years, unmarried, entered Passavant Memorial Hospital January 13, 1935. Regular menstruation during early years became more frequent and prolonged, changing to an irregular excessive flow at the age of 46. At the time of entrance there had been an amenorrhea for 7 months followed by profuse very dark bloody discharge which had persisted for 3 weeks.

Despite negative evidence on palpation of this virgin patient exploration of the uterus appeared necessary.

Operation. On dilation and curettage many pockets were encountered within the uterus and much succulent material was obtained. Because of multiple strictures and a suspicion of malignancy a vaginal hysterectomy was then resorted to. The tubes were found to be patent, but both tubes and ovaries were adherent and covered with innumerable superficial cystic nodules. The left ovary was largely replaced by a retention cyst. The uterus, opened after removal, was rigidly pockered and constricted both at the external os and at the internal os, with an intervening endocervical pocket the size of a walnut. The posterior cervical wall being thinned out and blemished. A polyp protruded into the cavity of the cervix. At the internal os the mucosa was rigid and corrugated, and the endometrial cavity above contained slimy dark fluid and innumerable polyps projecting into the lumen from the edematous moist mucosa (Fig. 14).

The microscopic structure of a broad based polyp at the right uterine horn revealed a papillary malignant growth.

Pathological diagnosis. Multiple strictures in a virgin uterus. Retention and back pressure of secretions with (1) endometrial polypoid development in the most uterine cavity, one growth in the right cornua presenting a picture of early papillary adenoma malignum, and (2) innumerable minute peritoneal cysts and slight adhesions of the tubes and ovaries.

In this case of obscure etiology occurring in a virgin patient obstruction and retention of secretions evidently predisposed to endometrial polyposis. One of the polyps presents a tendency to abnormal proliferation. Retro-

gradic spilling from the patent tubes may account for the adnexal pathology

CASE 9. A. G. aged 40 years married 16 years entered Passavant Memorial Hospital January 3 1933. There was a history of 2 births, one a forceps delivery with uncomplicated recovery after both. Two therapeutic abortions had been performed because of toxæmia of pregnancy. Subsequently in 1925 there was a pelvic operation with removal of adherent tubes suspension of the uterus and a vaginal trachelorrhaphy. Dysmenorrhœa present since puberty became more marked during the year following this operation. Premenstrual cramps of several days' duration became excruciatingly severe 6 months before she came to me. In 1933 and the menstrual flow established with difficulty became prolonged and profuse the history was typical of uterine obstruction.

At operation extensive adhesions were encountered throughout the abdomen being most marked in the pelvis. The right ovary was cystic and adherent, the left normal, the tubes were absent. The large uterus was buried in adhesions.

The uterus was opened after removal and it was found that amputation of the cervix at the previous operation had resulted in a snug fibrotic closure at the reconstructed external os, with some pocketing immediately above. In the vicinity of the internal os there was a ragged polypoid thickening of the endometrium with superficial necrosis. The involved area included nearly the entire circumference just above the internal os and was 1 centimeter in length. It apparently obstructed the lumen. A grossly recognizable wedge of invasion into the musculature suggested the possibility of malignancy. There was no dilation of the uterine cavity above (Fig. 15).

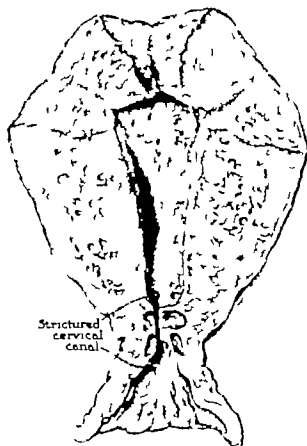


Fig. 12. Case 7. Massive uterus, 6½ inches in length with a lacerated frayed external cervix and a cystic badly strictured inner cervix terminating abruptly in a spacious uterine cavity; the body of the uterus presenting diffuse adenomyosis. (Two-thirds actual size.)



Fig. 13. Case . Photomicrograph of endometrium from lowermost portion of uterine cavity of uterus in Figure 12. Squamous cell metaplasia of columnar epithelium. X 100.

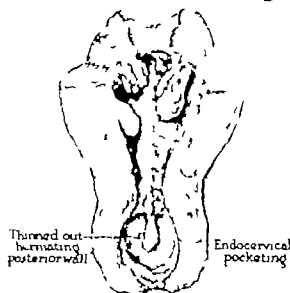


Fig. 14. Case 8. Virgin uterus with dense structures at the external os and the internal os, a dilated pocketed endocervix, accumulated fluid in the uterine cavity and endometrial polyp. Microscopic examination of the broad based polyp at the right uterine horn reveals a papillary adenoma malignum. (Two-thirds actual size.)

Microscopic study revealed marked cystic degeneration of the tissues in the region of fibrotic narrowing in the lowermost cervix. The tumorous growth above the internal os proved to be an early adenocarcinoma.

In this case a fibrotic narrowing at the external os apparently developed after a rather low operative repair of the cervix. Whether a polypoid growth occurred at the internal os because of retained secretions and a cancer developed in this region incident to and because of a benign tumorous obstruction or whether the malignancy occurred primarily and independently is a question. I assume that obstruction at the external os predisposed to the polypoid growth above whether the latter was primarily benign or malignant is problematical.

CASE 10. E. F. aged 27 years, married 7 years, never pregnant, reported for examination November 5, 1936. The uterus had been curetted 5 years previously and a year thereafter a Rubin test had been made. It was not certain whether the tubes were open.

When the patient came to me she complained of severe dysmenorrhea of 3 months duration. The uterus was well placed and no pathology was demonstrable on palpation, but a structure was found

in the cervical canal. It was dilated with much difficulty. A Rubin test demonstrated the patency of the fallopian tubes. The fibrous obstruction of the cervical canal was overcome by use of an electric cautery but the obstruction recurred repeatedly during the next several years. Dysmenorrhea of increasing severity became complicated by pelvic discomfort at other times and eventuated in a typical clinical picture of pelvic endometriosis.

At operation, September 15, 1934, the right ovary was found converted into a tarry cystic mass of four times normal size and extensive endometriomatous lesions were scattered elsewhere throughout the pelvis. The cervix was firmly strictured, the uterus in excellent upright position.

This patient evidently developed extensive diffuse pelvic endometriosis during the period that she was under my observation. The upright position maintained by the uterus throughout this time is a feature of interest. A persistently recurrent stricture of the cervix evidently created back pressure and retrograde menstrual spill into the pelvis and presumably was the cause of the endometriosis.

CASE 11. H. P. married, now 32 years of age has been under my care since a girl of 18, when she reported with a virulent gonococcal infection of the lower genital tract of 1 month's duration. The disease localized chiefly in the cervix and treatment was directed toward eradication of this focus upon subsidence of the active infection. The measures employed consisted of the usual procedures then in vogue—topical use of iodine and silver nitrate introduced on applicators, applied as gently as possible to the lowermost cervix, and later with failure of improvement to the endocervix at a higher level. The cervical canal became very tight and dilations were resorted to at various times. The stubborn persistence of a profuse creamy discharge led eventually to the intracervical use of radium. Occasional dilations of the cervix were required for the relief of distress from obstruction during the next 2 years but the symptoms gradually disappeared.

In 1925 a Rubin test revealed patency of the fallopian tubes. The uterus remained in an upright position, the adnexa apparently normal.

Two years later symptoms of cervical obstruction again recurred and the nasal tip cautery was applied to the endocervix under gas anesthesia.

There followed a period of 4 or 5 years of relative comfort. Menstruation was scanty but apparently without obstruction. Then the patient began to have scanty irregular menstruation with cramps and a discharge of dark menstrual blood. Pelvic distress increased and small fibroids were palpable in the uterus.

Operation April 10, 1934. Endometriomatous adhesions were encountered in the cul-de-sac. Firm bands held the sigmoid and rectum to the body of

the uterus, which was well placed and upright. The ovaries were small and healthy except for superficial endometriosis of the left.

The removed uterus contained multiple small fibroids and was atrophic. The cervix not more than half the usual size, was strictured at the external os, and in a pocket immediately above was $\frac{3}{8}$ cubic centimeter of fetid tarry blood. At the internal os was another stricture but no fluid was present in the endometrial cavity. The endometrium was atrophic. There were many small fibroids in the wall of the uterus, the largest the size of a plum.

This patient attended by me since she acquired a gonorrhoeal infection in her youth apparently developed a cervical stricture as the combined result of a severe infection and endocervical treatments directed toward eradication of the infection and relief of a persistently recurrent endocervical obstruction. Blocked drainage from the uterus may have been a factor in the etiology of the uterine fibroids and retrograde spilling of menstrual fluid was a probable factor in the development of pelvic endometriosis which occurred despite the upright position of the uterus.

CASE 12 B C Six years ago at the age of 27 this patient, married two and one half years, reported to a physician for examination because of a missed menstrual period and suspected pregnancy. An erosion was found and an electric cautery knife was applied to the cervix.

When first seen by me 9 months later there had been persistent amenorrhoea since the time of cauterization. The cervix was closed tightly the body of the uterus was soft and several times normal size.

At operation the cervix was found to be completely strictured the entire uterus converted into a soft boggy mass, the walls of the cervix thinned out to a thickness of a few millimeters. Two hundred cubic centimeters of dark liquid blood escaped upon opening the cervical canal.

The fallopian tubes were tested for patency 3 months later and were found to be obstructed but the obstruction was readily overcome. Sterility has persisted but pelvic discomfort which caused considerable distress for a year or 2 has gradually disappeared.

Stricture obstruction of the cervix required repeated dilations during the first 3 years following drainage of the hematometra but the canal has now remained patent for several months without dilation, although occasional use of a Hegar dilator is still necessary. Menstruation is scanty and there is evidence of an impending premature menopause at the age of 33 years.

Other cases of hematometra occurring in early married life have been encountered. It

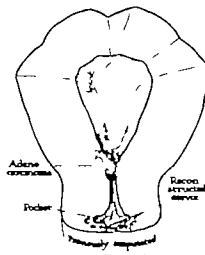


Fig. 15 Case 9 Diagrammatic illustration of uterus with a reconstructed cervix pocketed above, incidental to repair. There was gradual development of a tight external canal, with back pressure retention. Early adenocarcinoma just above internal os. (One half actual size)

is not a rare complication following avulsion of the cervix during delivery. Re-establishment of a satisfactory canal is exceedingly difficult unless corrected within a few months. Sterility is the rule. Retention of menstrual blood with complicating pelvic pathology has made surgical intervention necessary in the majority of cases which I have encountered.

SUMMARY AND CONCLUSIONS

1 The frequency of cervical strictures merits its repeated emphasis. They are of common occurrence in the practice of everyone concerned with pelvic diseases of women.

2 The various therapeutic procedures employed in treatment of lesions of the cervix are more important than any other factor in the etiology of cervical obstructions. Endocervicitis is also important in the etiology and in the majority of cases of serious stricture there is a history of an inflammatory process as well as of instrumentation. It must not be assumed however that absence of a history of infection or of instrumentation invariably gives assurance of a patent cervical canal and adequate uterine drainage. Strictures of the worst kind are encountered in virgin patients and in others in whom there is no discoverable predisposing factor.

3 Fibrotic constriction of the cervical lumen is much more serious than simple obstruction by adhesions. If drainage is not free

pocketing of the cervix may occur immediately above the fibrous obstruction

4 A metaplasia of the columnar epithelium into squamous epithelium has been found in the roughened pocketed *endocervix* above cervical strictures. A similar metaplasia has occurred in the pocketed *endometrium* above a cervical stricture. Irritation from retained secretions may be a factor in stimulating the metaplasia. (The question arises as to whether the seepage of irritating retained secretions from the pocketed cervix may be a factor in the production of leucoplacia of the external cervix.) We find here in the presence of leucoplacic squamous cell metaplastic tissue bathed in retained menstrual fluid and debris, a possible explanation of the frequent incidence of squamous cell cancer of the *endocervix* and adjacent *endometrium*.

5 Tumorous nodulations of the *endocervix* and lower uterine segment are a less common cause of uterine obstruction.

6 The effects of damming back of uterine secretions and menstrual blood may be far reaching—perhaps important in the etiology of endometrial polyps, adenomyosis of the uterus, pelvic endometriosis and back pressure inflammatory processes in the pelvis. The relationship of obstructive retention to the development of intra uterine cancer is a problem which merits further study.

7 If my individual experience is a criterion it will eventually be regarded as a surgical sin to use radium or make repeated endocervical topical applications, or apply the cautery within the cervical canal or amputate the cervix of the uterus, or even administer expectant care to a patient with notable endocervical disease without prolonged and attentive observation thereafter directed to the maintenance of patency of the cervical canal. Our thoughts have been too little concerned with the lumen of the uterus and the importance of free uterine drainage.

THE PREPERITONEAL LAYER—ITS GYNECOLOGICAL APPLICATION

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SUPERFICIAL to the peritoneum there is a definite layer of fibro areolar tissue containing varying quantities of fat, smooth muscle and elastic tissue. It is this structure which disorients the student about to make an incision into the abdominal cavity, especially in the midline.

Various names have been given to the layer. The term fascia endo-pelvina is confusing unless one adopts the classification in which two systems of fascia are recognized: the one a dense supportive tissue applied to voluntary muscle and the other an areolar fascia applied to abdominal and pelvic organs. Gallaudet called this layer the subperitoneal fibro areolar layer due to the fact that it is found beneath the peritoneum when the operator is working within the abdominal cavity. Others call it the extraperitoneal layer which in itself is incomprehensive because the muscular as well as the subcutaneous and skin layers are likewise extraperitoneal. The Germans refer to the layer as *Bindegeewebe* i.e. connective tissue because it is applied to and binds the various structures of the abdomen and the pelvis. The term preperitoneal accurately localizes the structure in the abdominal wall.

In the abdominal region the layer is closely related to the peritoneum as it ensheathes the adrenals, kidneys, ureters, vas colon, vessels and nerves but as it extends into the false and true pelvis it ensheathes the rectum, vagina, bladder, seminal vesicles and the prostate; it is apparently not so intimately connected with the peritoneum. It does however continue to lie between the peritoneum and the transversalis fascia which in the pelvis is called the supra-anal fascia. During youth the general tonicity and the deposit of fat aids in maintaining the supporting function of this structure but illness with the absorption of fat or old age with the diminishing of general tonicity predisposes to abdominal and pelvic relaxations. During the child-bearing period nature attempts to restore the

relaxed or lacerated structure by increasing the proportion of involuntary muscular and fibrous tissue thereby postponing the fatiguing symptoms of prolapsus until the support of pelvic congestion is removed by the menopause.

Considerable discussion exists as to the nature and the origin of the structure surrounding the vagina, uterus, bladder and the rectum. Each of these structures must perforate the musculo-fascial layers of the pelvic outlet to function normally and consequently their covering must fuse with the transversalis or supra-anal fascia covering the superior surface of the levator ani muscle. To assume that distensible organs are covered with a definite restraining structure such as that covering voluntary muscle is highly improbable but by beginning in the abdominal wall and tracing the preperitoneal tissue around the adrenals and kidneys into the false and true pelvis in a single sheet one can more readily understand the consistency and function of the structure without the use of a microscope. Histologically proving a structure does not interpret its relationship.

Pelvic surgeons are familiar with the terms pubocervical, paravesical, paravaginal, para-rectal, presacral, uterosacral, lateral ligaments of the vagina and pillars of the rectum but many fail to see that they are merely thickenings of the preperitoneal layer especially so around the vessels and nerves as they course from the lateral pelvic wall to the pelvic organs. It was because of a desire to comprehend this structure that this study was carried on.

In Figure 1 the peritoneum has been removed from a male specimen thereby exposing a continuous layer of preperitoneal tissue which extends from the abdominal into the pelvic region. It will be noted that the ureter, abdominal vessels and nerves are ensheathed and supported by this structure. As they are traced to the rectum and the bladder it is noted that the same layer envelops them.



Fig. 1

thereby protecting and aiding in maintaining their position. On the left the layer of preperitoneal tissue has been incised and retracted to expose the transversalis fascia covering the psoas muscle. Anteriorly retraction of the layer exposes the bladder and seminal vesicles. In the region of the seminal vesicles the involuntary muscular fibers of the layer are increased and probably aid in compressing the seminal vesicles during ejaculation since they are devoid of a muscular coat.

After removal of the coccyx and the lower segments of the sacrum preparatory to the removal of the rectum for carcinoma it is necessary to incise the preperitoneal layer before the rectum can be exposed. This layer has been called the presacral layer. In the same manner it is necessary to incise the preperitoneal layer to expose the seminal vesicles, prostate or bladder. With the Latsko cesarean section the layer is divided by blunt dissection and the bladder is retracted to expose the anterior surface of the uterus.

From the anterior surface of the rectum the layer can be traced anteriorly to the bladder. An incision in this region will expose the continuation of the transversalis fascia on the superior surface of the levator.



Fig. 2

To facilitate a comprehension of the structure in a female let us interpose the vagina and the uterus between the rectum and the bladder and at the same time perforate the levator and its fascial coverings, thereby establishing a communication with the vulva. The vagina and the uterus will then be ensheathed by the same layer as the rectum and the bladder from which it receives support, and especially from the thickened strands of involuntary muscular and fibrous tissue contained therein.

In Figure 2 the peritoneum on the right side of a female pelvis has been removed thereby exposing the preperitoneal layer about to be studied. By blunt dissection the layer was mobilized from the lateral pelvic wall as a wide sheet thereby exposing the continuation of the transversalis fascia into the false and true pelvis. It is noted that this procedure carried with it the contained rectum, vagina, uterus, and the bladder.

In Figure 3 the peritoneum was separated from the cul-de-sac, thereby isolating a distinct layer of preperitoneal tissue which lines the pelvis. Anteriorly within the layer is the bladder posteriorly the rectum while medially are the vagina and the uterus. The blood supply to the rectum comes from the superior and middle hemorrhoidal vessels which traverse this structure and except for the missing peritoneal covering is a structure not unlike a mesentery. The blood supply to

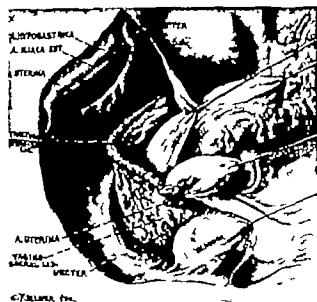


Fig. 3.

the bladder is from the superior middle and inferior vesical vessels which run in the preperitoneal layer from the internal hypogastric trunk to the lateral wall of the bladder. This organ can be then considered to be the center of a sling composed laterally of blood vessels and nerves contained within the preperitoneal layer.

The component parts of the uterus and the vagina, the muellerian ducts develop in the layer midway between the rectum and the vagina where they are supplied by branches from the internal hypogastric vessels. As they approximate each other and fuse, the uterus and the vagina are formed. They are likewise covered by a layer of thin preperitoneal tissue and are supported laterally by its vascular supply the lateral mesenteroids of the vagina. This term is used because the blood supply to the individual muellerian duct is not unlike a mesentery of the intestine except that it is devoid of a peritoneal covering.

Stretching laterally and posteriorly from the uterus is the familiar uterosacral ligament which is composed principally of involuntary muscular strands and fibrous tissue. However after the cul-de-sac is stripped of its peritoneum it is noted that the uterosacral ligament as such is not a distinct free muscular strand like the round ligament but it is the upper free margin of a distinct plane of tissue lining the true pelvis. That portion of

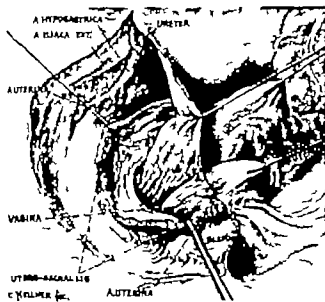


Fig. 4.

the plane distal to the uterus is attached to the lateral wall of the vagina and may be called the vaginosacral ligament or more descriptively the lateral mesenteroid of the vagina.

In Figure 4 the uterosacral ligament and the vaginosacral ligament have been incised proximodistally to its distal boundary the supra anal fascia.

In Figure 5 that portion of the preperitoneal tissue distal to the cul-de-sac is shown. The posterior portion depicts the divided uterosacral and vaginosacral ligaments there by exposing the preperitoneal layer covering the supra anal fascia between the rectum and the vagina. This layer contains branches from the middle hemorrhoidal artery which are distributed to the posterior wall of the vagina.

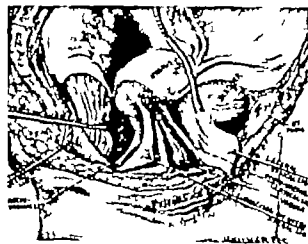


Fig. 5.

It has been called a pillar of the rectum because of the definite hypertrophy noted during operations for the cure of a rectocele. Structurally it is the rectovaginal mesenteroid and when overstretched or lacerated by child birth the rectum is permitted to bulge the lower third of the posterior vaginal wall.

Anterior to the vagina the vaginosacral ligament becomes continuous with the lateral vesical ligament which contains the vessels and nerves supplying the bladder. It has been separated from the lateral wall of the vagina and retracted anteriorly to show a structure similar to the rectovaginal mesenteroid which extends from the pubis to the urethra and from the urethra to the cervico-uterine junction. This structure is however rather intimately attached to the distal surface of the bladder and when relaxed or lacerated by childbirth throws an additional stress against the anterior wall of the vagina, which if similarly relaxed will result in the formation of a cystocele. It must be understood that the covering of preperitoneal tissue on the anterior and posterior walls of the vagina is of little value in the prevention of a cystocele or a rectocele but the rectovaginal mesenteroid and the pubocervical ligament are distinctly efficient.

RETROVERSION

In the upright posture the uterus appears to be suspended by the uterosacral ligaments, while traction by the round ligaments and intra-abdominal pressure force the fundus anteriorly. Utilization of the round ligaments is more efficacious than the plication of the uterosacra for the operative relief of this displacement. If however there is a tendency to prolapsus and a relaxation of the walls of the vagina insufficient for repair the plication or transplantation of the uterosacra will be of value.

PROLAPSE

During the third and fourth decades of life a retroverted uterus is able to withstand the stress of intra-abdominal pressure due to the support given to the uterus by its lateral attachments however with advancing years and a concomitant general relaxation the

lateral support permits a sagging of the uterus. An operation for retroversion together with a shortening of the uterosacra and a tightening of the lateral ligaments will relieve the condition. However as is usually the case other plastic surgery is needed below therefore the plication of the lateral uterine ligaments as suggested by Alexandroff is sufficient without opening the abdomen from above. The more extensive prolapse can be relieved by a vaginal hysterectomy. To obtain a deep vagina and at the same time increase the tonicity of the pelvic outlet the vault of the vagina should be closed from side to side thereby tightening the sling of the vaginal mesenteroids, which support the vagina laterally. This procedure while improving the tonicity of the vault will relax the uterosacral and the pubocervical ligaments unless definite steps are taken to unite them before the vault of the vagina is closed.

ENTEROCELE

A relaxation of the pararectal connective tissue together with a deep cul-de-sac, permits a herniation between the vagina and the rectum which is evidenced as a bulging of the posterior wall of the vagina above the usual rectocele. The approximation of the uterosacra from side to side will obliterate the cul-de-sac and act as an efficient barrier to a recurrence if at the same time other necessary vaginal repairs are done.

RECTOCELE

Prolonged stretching of the vagina tends to prevent proper involution of the vagina and the surrounding structures particularly the rectovaginal mesenteroid which acts as an accessory barrier to pressure from the rectum against the lower third of the vagina where the stress is more direct. The usual operative procedure in which the vagina is mobilized posteriorly and a triangular area of the relaxed tissue is removed together with a repair of the pelvic floor is often times sufficient. If however the rectovaginal mesenteroid is first isolated and plicated in the midline or transplanted above the crest of the rectocele as described by Dr. George Gray Ward a more defensive barrier is established. An at

tempt should be made to plicate or reattach this structure medial to the blood vessels therein so as not to alter the vaginal blood supply

CYSTOCELE

Prolonged stretching of the vagina together with the eversion of the anterior wall by the descending head tends to prevent proper involution of the anterior wall of the vagina and also the pubocervical ligament. Mobilization of the anterior wall of the vagina and the removal of the relaxed tissue restores the wall of the vagina and improves the tonicity of the lateral ligaments of the vagina which in turn fairly satisfactorily relieves the cystocele if however, the relaxed or retracted pubocervical ligament, which is closely applied to the bladder, is plicated and restored in the midline the tonicity of the bladder will be restored through the increased tension of the lateral vesical ligaments. To one's surprise the removal of the redundant vaginal tissue will appear unnecessary, other than for the relief of the relaxed vaginal wall. Dr William T. Kennedy has, likewise, repeatedly carried out this procedure. After a complete hysterectomy has been done the lateral ligaments of the vagina should be approximated in the midline and an attempt should be made to approximate the uterosacral and pubocervical ligaments over the vaginal vault particularly if there is a concomitant cystocele. This procedure definitely restores the tonicity to the floor of the bladder.

No reference has been made to the repair of the pelvic floor which must necessarily be repaired, if the efficiency of the lateral ligaments of the vagina and the musculo-fascial layers of the pelvic outlet are to be utilized most effectively.

CONCLUSIONS

1 The pelvic cavity is lined by a layer of preperitoneal tissue similar to the lining of the abdominal cavity

2 As the kidney is held by preperitoneal tissue, likewise are the pelvic structures supported

3 Prolonged distention of the vagina causes relaxation of the vaginal walls, the pubocervical ligament, and the rectovaginal mesenteroid

4. Following a complete hysterectomy, a deeper vagina can be obtained by closure of the vault from side to side rather than anteroposteriorly

5 A small cystocele can be treated from within the abdominal cavity by tightening the pubocervical ligament, or by reattaching it to the uterosacral ligament following a complete hysterectomy

6 Rectocele follows injuries to the posterior wall of the vagina and to the rectovaginal mesenteroid

7 Prolonged stretching of the vagina may relax the anterior wall as well as the pubocervical ligament which is rather intimately attached to the inferior surface of the bladder

8 Reconstruction of the pubocervical ligament in the midline, increases the support of the bladder through its lateral ligaments and makes the removal of the relaxed vaginal tissue appear to be an unnecessary procedure, other than to aid in the restoration of a normal contour

9 A granulomatous infection of the posterior portion of the vulva or the posterior wall of the vagina may extend to the rectum by way of the lymphatics in the rectovaginal mesenteroid and cause a rectal stricture about 3 centimeters from the anus

REFERENCE

- 1 DAVIES, JOSHUA WILLIAM. Abdominal and pelvic fascias with surgical applications. Surg., Gynec. & Obst., 1932 54 405-504.
- 2 Idem. The pelvic outlet. Surg. Gynec. & Obst. 1934, 58 70-78.
- 3 GALLAUDET B. B. The Planes of Fascia. New York Columbia University Press, 1931
- 4 WARD, GEORGE GRAY. Kelly's Gynecology New York Appleton 1928.

DIVERTICULA OF THE DUODENUM

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IN a woman of 80 dead of apoplexy Chomel found a duodenal pouch containing 22 stones. This case, published in 1710 is the first reference to pouching of the duodenum to be found in the literature. The sac is described as an extension of the membranes *vers le haut de cet intestin*. Morgagni refers to Chomel's case in his *De Sedibus*. The former thought the stones were gall stones, as the sac appeared to communicate with the common bile duct. In Morgagni's opinion these stones had passed through the bile duct and for some reason or other had been detained in the duodenum and had caused a diverticulum.

Morgagni mentions a case of diverticulum of the rectum and gives a full account of diverticulum of the duodenum 2 inches beyond the pylorus, discovered postmortem in the body of a man, also dead of apoplexy. The English translation (1769) of Morgagni's description runs thus

a kind of cellule, not very protuberating, but big enough to admit a finger surrounded with no coat but the external one of the intestine yet having not the least traces of any present, or past, ulceration in that part, as indeed there were not in the stomach, or the whole intestinal tube

In 1796 Rahn describes what was presumably a duodenal diverticulum secondary to an ulcer occurring in a woman of 22 who died from emesis. In 1815 Fleischman described 3 cases, all intimately related to the pancreatic and common bile ducts. Fleischman suggested as a cause frequent distention with food drink, or air. He also made reference to diverticula in the large bowel.

Habersohn in 1857 commented on the rarity of diverticula of the duodenum compared with those of the colon. He regarded them all as hernial protrusions of the mucosa through the muscular coat.

In the same year Harley described a pouch midway between the pylorus and ampulla of Vater in a man of 87. It contained a gall stone measuring 3 inches by 3¼ inches, and

weighed 450 grains. The gall bladder was thick and shrunken and buried in adhesions, while the common bile duct was dilated.

The first comprehensive survey was made by Roth in 1872 who after the study of 5 personal cases, concluded that diverticula of the duodenum are exclusively of the "false" variety they do not get larger than a pigeon's egg and are usually empty. "False" is used, apparently as opposed to "congenital."

In 1884 Turner contributed the first detailed description of the association between duodenal ulcer and duodenal pouches, and mentioned three varieties.

In 1893 Perry and Shaw made an extensive study of the postmortem records of Guy's Hospital describing 13 cases of diverticula of the duodenum. These they subdivided into (a) non-inflammatory and (b) depending upon operation or outside traction. These authors formed the opinion that the development of the non-inflammatory pouches depends upon abnormally high pressure inside the duodenum and their views in this connection will again be referred to.

The article of Perry and Shaw is the foundation stone of our present knowledge of the condition and those interested in duodenal diverticula can do no better than to commence their study with this article.

Other publications follow in more rapid sequence those of Fischer and Rolleston in 1900 of Keith in 1910 Baldwin in 1911 Moynihan in 1912 and of Linsmayer in 1914. This last work is a second landmark. Linsmayer's observations are based upon post mortem material. He expressly set out with the intention of investigating the condition, and was surprised to find 45 examples of the simple (non-inflammatory) type and 4 of the secondary type in 1,367 postmortem examinations.

In 1915 appeared the first recorded case diagnosed by X-ray and verified by operation (Forssell and Key). During the war years, apart from a preliminary observation in 1916

on the X ray diagnosis by Case little of importance occurred. The year 1920 however, was epochal. Papers by Spriggs and Marxer in England, Case in America, and Clairmont and Schintz in Germany described in detail the X ray appearances of duodenal diverticula. Wilkie's well known publication followed in 1921. Many excellent articles most of which are referred to in the following pages appeared during the last decade and a culminating point was reached in 1930 when Otto Hahn published an extensive "Review of the Literature of Duodenal Diverticula."

CLASSIFICATION OF DUODENAL DIVERTICULA

"Many instances of congenital intestinal diverticula of the duodenum have been recorded particularly in the second portion. Now that screen examinations after a bismuth meal are so constantly made duodenal diverticula have ceased to be looked upon as great rarities." This quotation from a recent exhaustive treatise illustrates the existing confusion with regard to the etiology of duodenal diverticula. The author has found that the vast majority of diverticula in this portion of the intestine are divided among the acquired hernial (or primary) type and those secondary to ulcer. The remainder are traction diverticula and anomalous forms. True congenital diverticulum—i.e., a diverticulum present from birth and identical in structure to the intestine from which it arises,—is a condition of exceptional rarity in the duodenum. This is a matter for surprise for one would expect the duodenum to be a fertile source in view of the development of the pancreas from it.

The possibility of there being a congenital factor in the etiology of the hernial type of diverticulum is conceded (although not supported), but this does not entitle this type to be called congenital diverticula for their morbid anatomy and their age incidence are diametrically opposed to the concept of a congenital status.

MATERIAL

The following account of acquired diverticula of the duodenum is based on the examination of the following material:

X rays 31 cases of which 26 are probably of the hernial type (primary acquired diverticula) and 5 of the secondary type. Of these, 3 are secondary to ulcer and 2 due to traction.

Pathological specimens 4 specimens of diverticula of the hernial type 7 specimens of diverticula secondary to ulcer.

Operation cases Three diverticula were exposed at operation 1 of which was secondary to an ulcer, and 1 due to traction by an adherent gall bladder. The third was removed intact (Fig. 7).

THE RADIOLOGICAL STANDPOINT

Incidence. During the 7 year period 1925-1931, inclusive, X rays have provided 31 examples of duodenal diverticulum. The total number of examinations made during this period was 4,631, so that in this series the percentage incidence is 0.67 per cent. The incidence of these cases in each year is as follows:

1925	1 in 521 X rays—0.19 per cent
1926	1 in 580 X rays—0.17 per cent
1927	1 in 630 X rays—0.16 per cent
1928	6 in 653 X rays—0.92 per cent
1929	6 in 612 X rays—1.47 per cent
1930	7 in 781 X rays—0.90 per cent
1931	6 in 854 X rays—0.70 per cent

The jump in incidence from the 0.2 per cent (approximately) of the 3 years 1925, 1926 and 1927 to 1.0 per cent (approximately) of the succeeding years coincides with the remodelling of the routine X ray technique in the early part of 1928, the chief added features being (1) screening of all cases (2) examination in the oblique position. In the first 3 months of 1928 before the technique was thus altered 1 case only was reported, but during the remaining 9 months 5 cases were reported. There can be no doubt that before 1928 cases of diverticula were being missed during examination and the percentages for these years do not represent the true incidence of the condition. If the years 1929, 1930 and 1931 are taken the figures are 22 cases in 2,247 X ray examinations, or a shade under 1 per cent. This compares very closely with the figures of Andrews, 26 cases in 2,200 examinations (just over 1 per cent) and Spriggs and Marxer, who found, in their first series 10 cases in 1,000 X rays (1.0 per cent). Case describes 85 cases in 6,847 X ray examinations (1.24 per cent). Spriggs and Marxer in 1925 however gave a

further series of 38 cases in 1 000 X ray films an incidence of 3.8 per cent while Cryderman found 45 cases in 770 X ray examinations (5.85 per cent).

Five of the author's 31 cases were definitely of the secondary type 3 being associated with clinical and other radiological evidence of a duodenal ulcer and 2 being in all probability traction diverticula. Another case in which barium entered the hepatic ducts, and which will subsequently be described is not included in these figures as the exact pathology is undetermined. Five cases in which some doubt existed are also excluded. The figures in tabular form are thus:

Total cases	31
Primary	26
Secondary	
With ulcer	3
Traction	2

These figures probably bear no direct relation to the relative incidence of the primary type and the ulcer type. It is not always possible even after screening and taking oblique roentgenograms to detect an ulcer diverticulum. One sees a fixed deformity of the duodenal cap but a diverticulum though present may be too shallow to show up clearly or its position may be such that it does not show in relief. Thus in Case 32 operation revealed a well defined pouch on the anterior wall of the duodenum that was wholly unsuspected by the radiologist (Fig. 1).

As opposed to the ulcer diverticulum primary diverticula show up readily in a thorough X ray examination. Confusion exists in some cases between a primary diverticulum and a dilatation of the common bile duct. It may be in fact impossible to distinguish between these two conditions—they may be associated in the same case—on radiological evidence alone.

Contrary again to the ulcer diverticulum the primary type is detected more easily radiologically than at operation. The latter all arise from the second and third parts of the duodenum and many lie behind or are overlapped by the pancreas. It is sometimes only with difficulty that a diverticulum can be found at operation even when its presence is known beforehand and a definite search is made.

The same applies to postmortem examination at which diverticula will easily be missed unless the examiner is alive to the possibility of their occurrence and opens the duodenum throughout its whole length, so that he may examine its concave margin carefully from the mucous membrane side.

Radiological appearances. Duodenal diverticula are seen as smooth barium filled pockets persisting at a 3 hour or 6 hour roentgenogram. Unless large and well defined a pocket in the first part of the duodenum associated with an ulcer will not be revealed. The duodenum may show marked deformity—often the shamrock-leaf deformity described by radiologists as typical of duodenal ulcer—but no definite diverticulum. Furthermore, the pockets secondary to ulcer are in most cases shallow and wide mouthed and there is no retention of barium in them. They empty with the duodenum.

On the other hand in Case 32 a well marked ulcer diverticulum was seen without difficulty at operation (Fig. 1) but was unsuspected at X ray examination. It is frequently impossible to establish the exact point of opening of a diverticulum into the duodenum, and a differential diagnosis between ulcer diverticulum and the primary type cannot readily be made. If however peristalsis is seen in the wall of the diverticulum it is certain to be of the ulcer type. Diverticula of the second part of the duodenum, the commonest site for diverticula of the primary type, are readily seen by X ray and if the routine described above be followed will rarely be missed.

Figure 2 is selected as a typical example. In this case the colon was also the seat of multiple diverticula. A partly filled but well defined pouch in the concavity of the duodenum is shown. It empties into the second part of the duodenum and there was no retention of barium after 3 hours. The question of barium retention after the duodenum is empty must be carefully studied as only in such cases can the diverticulum be suspected of causing symptoms.

Diverticula of the horizontal and ascending parts of the duodenum are rarer and not so readily seen. This latter point may in fact,

be a partial explanation of the rarity of this finding as compared with diverticula of the second part.

The oblique position for examination is of especial importance in revealing diverticula near the flexure, and increasing frequency of incidence of diverticula in this situation during the past 3 years is due in part to the adoption of this routine.

In diverticula of the horizontal portion the mouth of the diverticulum is on the concave surface of the duodenum and the sac in the great majority of cases passes upward in relation to the pancreas. With this dependent drainage, the barium may not enter the diverticulum, or if it does so remain for so short a period that it escapes detection. In the rare cases in which the diverticulum has increased in size so much that it hangs downward its presence is readily detected, for stasis will always be present.

Buckstein, writing in 1927 and before oblique views were adopted as a routine recommended a duodenogram for showing up doubtful cases of diverticula near the flexure in which position, he states, they may be confused with an ulcer crater on the lesser curvature of the stomach. A radio-opaque duodenal tube the first 10 inches of which has many small perforations made in its wall is swallowed until the duodenojejunal flexure is reached, as determined by examination under the screen. A thin suspension of barium is then slowly injected and an X ray is taken immediately, so that an outline of the duodenum alone is obtained.

The oblique view has in our opinion however, obviated the necessity for this elaborate technique, and the print published by Buckstein is not sufficiently convincing to warrant a trial of this method.

Traction diverticula are rare and difficult to distinguish radiologically from other types. Points to be noted in arriving at the diagnosis are the shape and fixation of the shadow. The diverticulum may not have a spherical rounded appearance but a somewhat conical outline. It will be fixed to neighboring viscera.

The most frequent sites for traction diverticula are in the gall-bladder region and at the

flexure, where occasionally the intestine may become caught up by perigastric fibrosis around an ulcer of the lesser curvature of the stomach.

Identical X ray appearances, however, may be caused by secondary inflammatory changes occurring in the primary form of diverticulum.

Pitfalls in X ray diagnosis. Occasionally extra luminal flecks of barium in the first and second parts of the duodenum remaining after emptying of the gut will rouse suspicions of the presence of a diverticulum. A second examination should be made in such cases, and attention in screening carefully focused upon these abnormalities. Such shadows in the first part may be due to the presence of a small ulcer crater and in the second part to barium getting into a dilated common bile duct or to the anatomical variation of the opening of the bile and pancreatic ducts into the duodenum. In cases in which a smooth rounded appearance of the shadow cannot be obtained on palpation of the duodenum, a confident diagnosis of diverticulum cannot be made. Five such cases occurred in the series of X ray plates under review (not included in the 31 cases of diverticula).

Anatomical variations in the duodenum may give rise to some difficulty in the diagnosis. Heacock describes a case of pseudo-diverticulum due to a fixed redundancy of the duodenum without any defect in the wall of the intestine. This condition was confirmed at operation. Larimore also draws attention to this appearance. It is a degree of that duplication of the duodenum described first by Wilkie. In these cases, the longitudinal plica, which terminates at the ampulla, stands out as a well marked fold dividing the second part of the duodenum vertically into two compartments. The condition is undoubtedly a minor variation of complete duplication of the duodenum described by Calder, in which two definite tubes existed. Fairland described such a duplicature of the whole tract from the pylorus to the cæcum. Wilkie also describes an infolding of the duodenal wall in the transverse axis giving rise to a ring like constriction. He thinks it is a mild form of the duodenal stenosis met with occasionally in children.

These appearances are readily distinguishable from those of a diverticulum by careful screening especially in the oblique view. The normal 'feathery' appearance of the duodenum in duplicature is retained without interruption.

Other departures from the normal topography of the duodenum should not give any difficulty. Differences in shape, the enlarged bulb due to an annular pancreas, abnormal positions and ileus are not readily to be confused. Shadows occasioned by other things, such as gall stones and pancreatic stones, will be excluded.

Unquestionably the most important procedure in X-ray diagnosis is the screening operation—palpation of the duodenum under observation. It transcends in importance the fixed roentgenograms with which the clinician is furnished and outweighs any conclusions that may be deduced from these impressions.

PRIMARY ACQUIRED DIVERTICULA OF THE DUODENUM

Of the author's 5 specimens (4 postmortem and 1 operation) 4 are examples of single diverticula arising in relation to the entrance of the common bile duct (perivaterien). In the fifth 2 diverticula are present arising from the transverse part of the duodenum.

Specimen 1. The specimen illustrated in Figure 3 was obtained postmortem from a woman of 77 years, who died following an operation upon a carcinoma of the colon (Case 6). Diverticula were present also in the large intestine.

The duodenum has been opened by dividing the anterior wall in the midline. Bristles have been placed in the common opening of the common bile and pancreatic ducts in the ampulla of Vater and in the opening of the duct of Santorini above. The major ampulla is unduly prominent. Its right margin is continuous with a transverse plica which forms the anterior lip of a wide mouthed diverticulum, and which then continues as a well defined transverse plica on the posterior and right lateral wall of the intestine.

The direction of the diverticulum is to the left, and slightly upward and backward, following exactly the same course as the common bile duct through the duodenal wall. On the reverse side of the specimen, the diverticulum could be seen as an ill defined bulge of the duodenum into the pancreas. It is separated from the latter by a narrow interval filled with loose areolar tissue, and the pancreas

could be freed by blunt dissection. The mucous membrane lining the pouch is smooth and free from rugae, but otherwise normal. A microscopic section of the wall at the fundus of the diverticulum shows only a small number of muscle fibers lying in a thin wall of fibrous tissue. A large vessel is lying within the wall.

Specimen 2. The specimen illustrated in Figure 4 is from a dissecting room subject. The pancreas has been removed except for a small portion of the head in immediate contact with the concavity of the duodenum. This has been dissected free, and turned upward. Between the pancreas and the common bile duct there is a large diverticulum. This is flask shaped, but not completely regular in outline. This fact is due in part to irregular shrinkage following prolonged preservation in a formalin solution. The wall of the diverticulum is as thin as tissue paper and transmits light equally well. Microscopic sections show the wall to consist of a very thin layer of fibrous tissue, with no trace of a muscle coat. The mucous membrane has been partially destroyed by autolysis.

When the duodenum was opened, it was found that the relation of the mouth of the diverticulum to the ampulla of Vater was similar to that in Specimen 1.

Specimen 3. The specimen illustrated in Figure 5 is from a dissecting room subject, a man of 79. The duodenum is an unusually large one, but no obstruction was present. The walls are of about normal thickness, there being no evidence either of thinning from passive distention, or thickening from hypertrophy. A small portion of pancreas remains attached to the duodenum, and is retracted forward by a hook. Between this portion of the pancreas, and above and in front of the common bile duct, is a large diverticulum. It has been packed out with cotton wool, but before this was done was lax and collapsed. The wall is extremely thin and readily transmits light. The mucous lining is smooth, and contains no rugae. The diverticulum in the recent state lay posterior to the duodenal margin of the head of the pancreas from which it was separated by a thin layer of areolar tissue.

The relation of the mouth of the diverticulum to the ampulla of Vater is as in Specimens 1 and 2.

Specimen 4. This specimen, illustrated in Figure 6 was obtained in the dissecting room from the body of a man aged 71. To obtain the illustration, the specimen was suspended, and viewed from above and behind. A portion of the head of the pancreas remains attached. Two small diverticula are present, opening from the transverse portion of the third part of the duodenum, the second one (nearest the "camera") being at the junction of this part with the ascending part of the duodenum. The double row of blood vessels supplying this part of the duodenum, to be described in full subsequently is clearly seen.

The outline of this diverticulum is indicated by an interrupted line, as it was removed with the

intestine before the drawing was made. Whole serial sections were cut, one of them passing through the maximum girth of the diverticulum.

The double row of blood vessels supplying the duodenum to which a detailed reference will be made later is clearly seen, one row lying posterior and the second anterior to the midline. The latter is represented by the thick interrupted line in the illustration.

In each case, the opening of the diverticulum is to the posterior side of the midline, in relation to one of the posterior row of blood vessels. This is very clearly shown in the smaller diverticulum, for the section through its base has cut through an artery which ran into the wall of the diverticulum and is well shown in the section.

Microscopic appearance. A section passing through the maximum diameter of the diverticulum which is completely devoid of a muscular layer shows that the muscle of the duodenum ceases abruptly at the mouth of the diverticulum and there is no suggestion of it being carried along in its wall. The muscle in the angle between the intestine and the pouch appears to be a little thicker than elsewhere in the duodenum as though it had undergone a certain amount of hypertrophy. A large artery can be seen between the submucous layer of the diverticulum and the muscularis of the duodenum and its companion vein is seen as a long narrow chink. This artery corresponds with the one cut across, as shown in the illustration. The diverticulum consists of an extremely thin layer of fibrous tissue covered with serosa, and lined by mucous membrane the latter is thin and contains no rugae. No pancreatic tissue or Brunner's glands are present.

Specimen 5 (Fig. 7). Perivaterien diverticulum removed at operation from a woman of 54 years. It is a thin walled sac, devoid of a muscular coat and having a cubic capacity of 14.5 cubic centimeters. The radiological appearance is shown in Figure 8. The patient complained of abdominal pain, with occasional sickness, and a distressing amount of flatulence after meals. The history extended back for some 9 or 10 years and the symptoms had become progressively worse despite periods of treatment elsewhere for gastric ulcer. Six years before admission appendectomy had been done with no relief. No other cause for the symptoms was demonstrated, and removal of the diverticulum resulted in a complete cure of the distressing flatulence. The patient still complains of occasional pain, but this has very greatly improved, and 11 months after operation her weight had increased from 7 stone 6 pounds to 8 stone 10 pounds.

A typical primary duodenal diverticulum is thus a thin walled sac opening into the bowel by a wide mouth. Except in exceptional instances it rarely exceeds the size of a golf ball. It is rounded in shape, as opposed to the finger like congenital type of diverticulum found

in the ileum. The edges of its mouth are well defined, sometimes being sharp and crescentic, as the diameter of the diverticulum beyond the opening into the bowel immediately begins to increase. The edge may be in continuity with one of the plicae inside the lumen of the intestine. The lining of the pouch is smooth, and there is a complete peritoneal covering. In all the cases there is a close relation either to one of the ducts piercing the duodenal wall or to a blood vessel.

When one holds the opened duodenum up to the light, the thinness of the diverticular wall compared with that of the duodenum is at once evident and it is clear from this simple test alone that there is a gross deficiency of the muscular coat.

Microscopic examination of the wall of the diverticulum confirms this view. If the section is taken from the fundus, practically no muscle tissue is to be seen, except for a thin layer not more than one or two fibers deep, usually to be found and which represents the muscularis mucosae. This layer, as in diverticula of the large bowel may be well defined, being thicker, in fact, than in the intestinal wall. This is due to compensatory hypertrophy owing to the deficiency of the muscularis proper. As the wall is examined toward the mouth of the sac, muscle fibers may become more abundant. If a section is now examined which passes through the edge of the opening into the bowel, so that portion of the wall of both the diverticulum and the bowel be included, it is at once clear what has happened. At the angle formed by the abrupt change of direction of the lumen at the lip of the mouth, the muscular coat of the intestine appears to be unusually thick. Immediately, however, there is a diminution in thickness, shared by both the circular and longitudinal fibers and both layers become equally and progressively attenuated until the muscular coat fades away completely, or is represented by an interrupted thin line of muscle not more than one or two fibers in thickness. Toward the fundus it may be difficult to decide whether or not such fibers belong to the muscularis mucosae.

The mucous membrane itself is thinned, but in uncomplicated cases shows little depar-

ture from normal except in the absence of any Brenner's glands

The microscopic description given does not tally with that of all observers. For example Baldwin states that all his 15 postmortem cases are "true, as they all contained muscle. But he says this consisted of a single layer and therefore probably belonged to the muscularis mucosæ. In his summary of the literature previous to 1911 in 47 cases no microscopic report was made. In 20 other cases muscle was found, and in the 16 remaining it was stated to be absent. Jenkinson mentions an operation case with muscle in the wall but gives no detailed description. Basch in another operation case states

muscular coat thin but intact. Jackson describes a case in which the muscularis mucosæ is hypertrophied with a definite but thin true muscle coat. In Moore's case, the muscularis mucosæ is thickened but there is no true muscle coat. In Rolleston and Fenton's 4 cases no muscle was found at all. Diverticula secondary to ulcer have a complete muscular coat. They are in no sense herniations of the mucous membrane through the muscularis of the intestinal wall and a great deal of the conflicting evidence is due to confusion between the ulcer type and the primary type of diverticulum.

It may be concluded therefore that in primary diverticula of the duodenum the true muscular coat is grossly deficient, sometimes to the extent of complete absence.

AGE INCIDENCE

The average age in 25 of these cases is 51.9 years, the eldest being 73 and the youngest 31. In Cryderman's 45 cases diagnosed by X-ray the average age was 51.7 the youngest being 24. There is thus a close agreement between the two series.

There is a striking difference, however in the average age figure between these two X-ray series, and the postmortem series of Linsmayer, Baldwin and Nagel as can be seen in the tabulation on age incidence. If the average age of the combined postmortem figures be taken as 63 a difference of no less than 11 years exists—and is a striking indictment against the policy of accepting

AGE INCIDENCE

		Cases	Average age	Youngest	Oldest
X-ray	Author	25	51.9	31	73
	Cryderman	45	51.7	24	
Postmortem	Linsmayer	33 (single case)	64	36	81
	Baldwin	1	66	47	82
	Nagel	20	61	28	87

the age incidence of any conditions of this type which is based upon postmortem material alone. In 3 of the author's postmortem cases, the average age is 76.

It is difficult to determine the youngest recorded case of primary diverticulum, for records of the past have been so mixed up with diverticula associated with ulcer (in which the age incidence is younger) that one is forced to ignore them. Cryderman's youngest case of 24 might be accepted with the proviso that it was an X-ray diagnosis, and did not pass the absolute test of visual inspection. Huddy's case of acute perforation of a diverticulum of the second part was in a woman of 27. Pilcher's case, reported in 1894 of an enormous pouch interrupting the transverse portion of the duodenum in a boy of 17 had a wall of inflammatory fibrous tissue. It was in all probability a false diverticulum resulting from perforation of the duodenum. At all events the pathology is not sufficiently clear to warrant its acceptance as a primary duodenal diverticulum.

The point which emerges quite clearly from this discussion is that primary diverticula of the acquired type are unknown before the age of 24 and rare before the age of 30.

SEX INCIDENCE

Of 26 cases, 15 were in women and 11 in men. The average age at discovery of the diverticula is, men 49 years and women 52.6 years. Linsmayer's figures are women 27 men 14 and Cryderman's, women 30, men 14. In Baldwin's summary of 67 specimens found in the literature up to 1911 the sex was stated in 35 cases 21 of which occurred in men, and 14 in women. This series cannot, however be regarded as an accurate repre-

sentation as certainly not all the cases in which the sex is mentioned after excluding all cases in which there is any doubt as to the type of diverticulum described the distribution between the sexes is men 112 women 151

SITUATION

By far the greatest number of primary acquired diverticula occur in the second part of the duodenum in close relation to the entrance of the common bile and pancreatic ducts.

The author has not been able to find a single proved case of primary diverticulum in the first part of the duodenum. This is an observation of the greatest significance for although not ruling out all possibility of their occurring in this situation it denotes at least that they like true congenital diverticula must be of extreme rarity and this fact permits the clinician to regard all diverticula of the first part as secondary diverticula. The vast majority of these are due to the presence of an ulcer.

Diverticula of the third part of the duodenum though far less frequently found than in the second part are by no means uncommon. In the 26 X-ray plates 3 postmortem cases and 1 operation case (the first post mortem specimen is included with the X-ray plates) the distribution is as follows:

First part	0
Second part	22
Third part	9
Horizontal limb	4
Vertical limb and flexure	5
Total	31

1 case with 2 diverticula

DISTRIBUTION

The more complete of the series to be found in the literature are shown in the tabulation on distribution.

If the author's cases are added it will be seen that of the 280 cases in which the position has been noted no less than 204 or 73 per cent are situated in the second part.

These figures however show considerable variations in the relative frequency in the various parts. Whereas Baldwin and Spriggs

DISTRIBUTION

	Year	Author	Total	First part	Second part	Horizontal part	Vertical part
Post mortem	1911	Baldwin	5	0	9	5	1
	1914	Linsmayer	4		4		
	1920	Cave	65	0	49	10	
X-ray	1920	Cole and Roberts	26		3		
	1925	Spriggs and Marner	50	0	30	6	4
	1927	Cryderman	40		30	9	
			220	0	182	67	

and Marner find a steady diminution in frequency from the second part to the flexure. In the author's figures diverticula of the ascending part and the flexure and the horizontal limb are in the proportion 5 to 4. The most marked variation from the mean is in Linsmayer's records for in his 41 cases examined post mortem all of them were in the second part. One is at a loss to account for this for anyone who studies Linsmayer's excellent article cannot fail to be convinced that his observations have been made with care.

MULTIPLE DIVERTICULA

In only 1 personal case was more than one diverticulum found. Two diverticula are not, however uncommon as reference to the literature shows. More than two are rare. In an unusual case described and fully investigated by Odgers no less than five pouches were present. Their distribution is as follows: the first 4 centimeters above the ampulla of Vater the second and third perivaterien, the fourth at the upper border of the transverse part dorsal to the pancreas, the fifth at the junction of transverse and ascending parts.

This specimen has been beautifully dissected and is to be found in the Museum of the Royal College of Surgeons.

In their X-ray survey Spriggs and Marner found two pouches in each of 38 patients. In 12 specimens Keith found two pouches in 3 cases. These were paired on either side of the ampulla. Rolleston and Fenton describe a 'bifid diverticulum—identical, apparently, with Keith's in appearance—having a pouch on either side of the ampulla. These authors suggest that this was originally a single pouch



Fig. Diverticulum of the duodenum associated with ulcer. (From sketch made at operation.)

divided into two compartments as a result of tightening of the common bile duct following *visceroptosis*.

Fleischman describes a case with four diverticula, 1 with three and a third with two and Roth 2 cases with two diverticula in each.

In 20 cases Nagel found 6 with two pouches. All were *perivaterien*. Linsmayer in 41 cases found 7 with two and 1 with three.

The diverticula are all necessarily related to the pancreas lying either behind it or partly buried in its substance. In the 15 cases of Baldwin 8 were posterior 3 lying below it and 4 in its substance.

MORBID ANATOMY IN RELATION TO PATHOGENESIS

Situation in relation to the wall of the bowel. In all cases, without exception the diverticula arise from the concave surface of the bowel and are therefore closely related to the pancreas—a relation which those seeking a congenital theory of origin emphasize very strongly. There is little doubt however that the situation on the concave surface is due to the weak areas in the bowel occasioned by the passage of the common bile and pancreatic ducts and the blood vessels. The greater size of the common bile and pancreatic ducts and the long passage obliquely through the wall lead one to expect a greater frequency of primary diverticula associated with it than with the vessels and indeed it is

so as the figures heretofore given show. The third part of the duodenum, though nearly twice as long as the second portion provides only 27 per cent of the total number of cases. All these cases of the second part lie in the concavity of the duodenum, and at or near the ampulla of Vater. Although one cannot define the exact relation of the diverticula to the ampulla in cases examined by X-ray alone postmortem records show that the greater number are intimately related to it. So common is this relation that French writers have coined the descriptive term "*perivaterien*" for diverticula of the second part of the duodenum.

Anatomy. The common bile duct and pancreatic duct of Wirsung run obliquely through the duodenal wall for one-half to three-fourths of an inch and open into the ampulla of Vater on the left wall of the duodenum, slightly to the posterior aspect. The union of these ducts does not take place until they have almost reached the opening in the duodenal papilla. The exact mode of termination of the ducts is subject to slight variations.

The passage of the ducts through the duodenal wall necessitates a considerable gap in the muscle fibers. The longitudinal coat is most affected for in the angle between the tracks of the pancreatic and bile ducts a well defined circular coat exists, whereas the divarication of the muscle fibers of the longitudinal coat is practically continuous.

The pancreatic duct of Santorini pierces the duodenal wall three-fourths inch above and somewhat anterior to the main duct and terminates in a minute orifice which is often difficult to find even on examination of post mortem specimens.

The weakness occasioned by the separation of longitudinal fibers probably continues for some distance below the entrance of the ducts.

The blood vessels. The duodenum is supplied by the inferior pancreaticoduodenal artery of the superior mesenteric and the superior pancreaticoduodenal of the gastroduodenal branch of the gastric artery. The first part also receives some branches from the pyloric artery.

Figure 9 illustrates the dissection of blood vessels after injection with carmine. For the

sake of clearness, the pancreas has been dissected free from the superior mesenteric vessels and common bile duct. This has necessitated division of the small branches of the pancreaticoduodenal arteries supplying the pancreas but has left the duodenal branches undisturbed.

The inferior pancreaticoduodenal is a short thick trunk at its origin from the superior mesenteric, and almost immediately gives rise to a large branch which passes to the left and follows the concave curvature of the duodenum (under cover of the inferior margin of the pancreas) to the flexure. In the specimen dissected the main artery now divides into two branches from which the bowel is supplied by a double arcade anterior and posterior. The anterior branches are easily visible under the peritoneum covering the anterior wall of the duodenum but the posterior branches run under the lower margin of the pancreas.

As the vessels pass to the right they run to either side of the common bile duct and terminate by anastomosing with similar dorsal and ventral branches of the superior pancreaticoduodenal artery. The dorsal and ventral branches in this case arise independently from the gastroduodenal artery.

This arrangement of the duodenal blood supply does not correspond in detail with that described in standard textbooks of anatomy. Similar findings however are reported by Yule, whose article the author discovered after his own dissections were complete.

There is thus a double arcade of supply to that part of the duodenum from a point above the entrance of the common bile and pancreatic ducts and the point at which the superior mesenteric artery crosses the intestine.

If a cross section of the horizontal portion of the duodenum be examined it is seen that the anterior and posterior series of branches are separated by a considerable interval—five-eighths to three-fourths inch at the points at which they pierce the duodenal wall (Fig. 10).

This relation coincides with the situation of diverticula in the third part. Some of the latter are easily visible and anterior their opening being in the same plane as the ante-



Fig. 2. Pulsion diverticulum of the second part of the duodenum 1½ hours after a barium meal. The barium in the colon is due to a barium enema given 3 days previously.

rior branches. Others are posterior, and hidden the opening corresponding with the posterior branches.

Perivaterien diverticula. Perivaterien diverticula are situated in the concavity of the duodenum immediately above the opening of the common bile duct.

In Keith's article 7 single cases are described in this situation. In the 3 cases in which two diverticula are present the pouches appear one on either side of the common bile duct. The right one is in each case the larger. One cannot fail to appreciate Keith's view that in the cases in which two are present we are seeing merely a further stage in the single cases in the formation of these diverticula.

A few cases are to be found in the literature in which the common bile duct or pancreatic duct or both actually open into a diverticulum. I suspect some at least of these cases as being exaggerations of the condition of wide mouthed opening of the common bile duct. Traction by the common bile duct following inflammation in the biliary tract might cause such an opening to be pulled up into a

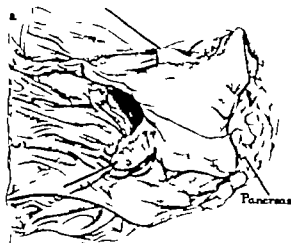


Fig. 3. Diverticulum of the second part of the duodenum

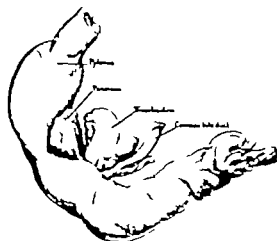


Fig. 4. Diverticulum of the second part of the duodenum

diverticulum of considerable size as in the case recorded by Benninghoven and Michael. One case in which the accessory duct of the pancreas opened into a diverticulum is also recorded.

The second most frequent site in the second part of the duodenum appears to be above the ampulla but in the same plane and associated with the opening of the accessory pancreatic duct of Santorini in the minor papilla.

Baldwin's analysis of the cases in the second part in the literature up to 1911 and including his own is as follows:

Convexity of duodenum	Cases
Concavity of duodenum	53
Near pylorus	5
Near minor papilla	9
With accessory duct opening into it	1
Near major papilla	2
At major papilla	24
Wirsung's duct opening into it	3
Both ducts opening into it	4

THE THIRD PART—TRANSVERSE ASCENDING AND FLEXURE

In the author's case of double diverticulum the relation between the mouths of the diverticula and the entry through the intestinal wall of two posterior branches of the superior pancreaticoduodenal artery is clearly shown. This relation is so close that there can be no doubt that the pouches herniated through the gap in the musculature occasioned by the entry of the blood vessels. Grant describes a

similar case in which were present two diverticula of the transverse part in the line of the opening of the common bile duct suggesting that a weakness persisted in the longitudinal muscle fibers after being pierced by the duct for some distance along the concave border of the duodenum. That this may be a factor cannot be disputed. A large vessel was, however associated with both diverticula. It bifurcated at the fundus, one branch going to the posterior and the other to the anterior surface of the diverticulum in each case.

When the diverticulum which commences as a small herniation of the mucosa through a gap in the muscular wall increases in size as a result of intraduodenal pressure its mouth increases in size, and takes up more and more of the diameter of the intestine. Thus in a number of cases the exact point of commencement of the pouch cannot be identified. A protrusion of the mucosa occurs on either side of the midline corresponding with the entry of a vessel. As these increase in size they eventually fuse opening into the bowel by a wide mouth which bestrides the midline (corresponding with the mesenteric attachment in the case of the jejunum).

The case with which diverticula are found at operation will depend largely on whether they start in association with the anterior or posterior branches of the superior pancreaticoduodenal artery. The latter will be completely



Fig 5 Diverticulum of the duodenum

obscured by the overlying pancreas. In the transverse part the mouths of the diverticula open downward and the pouches therefore drain readily. The diverticula probably because of this do not tend to get large. The fact that only 2 cases were shown in the author's series of 26 X ray cases may be accounted for by the same token the barium only remaining in the diverticulum for so short a period of time that it escapes the eye of the examiner.

The terminal portion and flexure. Diverticula of the flexure pass inward to the right and below the lower border of the body of the pancreas. This situation is constant though the exact point in the diameter of the bowel from which they arise has not been determined.

Their semidependent position may account for the large size to which they sometimes develop. Jacquelin and Quénu report a diverticulum removed at operation from a woman of 54 which opened from the bowel near the flexure and passed to the right behind the peritoneum as far as the left border of the duodenum. It measured 8 by 2 centimeters and was easily seen in X ray examination. Lund describes a very similar case in which operation was also done. The diverticulum passed from the region of the flexure behind the first part of the duodenum to reach the posterior aspect of the gall bladder. X rays had shown its presence before operation. One or two diverticula were also found in the beginning of the jejunum.

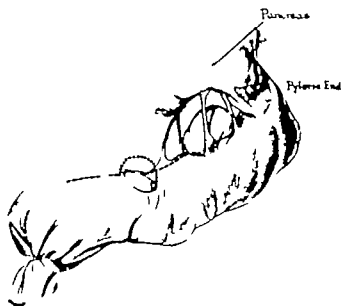


Fig 6 Diverticula of the third part of the duodenum

Diverticula at the flexure play a prominent rôle clinically owing to their tendency to cause symptoms suggesting obstruction to the passage from the duodenum into the jejunum. Krogus describes a case of acute obstruction due to this cause in a woman of 64.

THE PATHOGENESIS

That diverticula such as have been described in the preceding pages are acquired and not inborn is placed beyond reasonable doubt by the age incidence of their discovery. One cannot on the same ground however dispose of the possibility of a congenital factor being responsible at all events in part for their development. Though I should like to state at once that my own investigations do not lead me to subscribe to the likelihood—or even the necessity for postulating such a factor—one cannot pass by the views of men such as Professor Wilkie who formulated so emphatically a congenital theory of origin some 20 years ago without being conscious of some loss of confidence in the validity of one's own conclusions.

The first source of guidance as to the pathogenesis lies in the structure of the wall of these diverticula. There is uniformity of opinion that the muscular coat is deficient. In all my own cases there was a complete lack of muscle at the fundus of the diverticulum, except

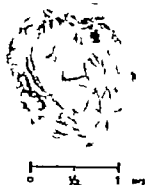


Fig. 7 Diverticulum removed at operation from the second part of the duodenum

for that belonging to the muscularis mucosæ. Failure to state the exact place in the diverticulum from which a section was cut and upon which the opinion was formed as to the nature and quantity of muscle found compels one to rely on one's own limited pathological investigation and the comparatively few cases in the literature in which this is clearly stated.

Two views are possible with regard to the muscular deficiency. Either the muscle is deficient from the commencement or it was normal to begin with and became thin as a result of pressure. This latter event appears to be the explanation of most of those who regard the diverticula as of congenital origin. This sequence of events is however unlikely. Congenital diverticula of the ileum do not behave in this way and indeed there is no reason why abnormal pressure inside the duodenal lumen should of its own accord cause atrophy of the muscle of the diverticular wall any more than that of the duodenum whence the diverticulum opens. Tandler has shown that in the early stages of development of the duodenum the epithelial lining of the gut develops in advance of the mesodermal coats, and Wilkie suggests that the outgrowth of an accessory pancreatic bud in the region of the hepatic and the two pancreatic ones at such a stage might result in a diverticulum with an imperfect mesodermal sheath. But in not one of the author's cases was there any question of direct connection between the pancreas and the diverticulum. The latter was in each case separated by a layer of areolar



Fig. 8 X-ray appearance of diverticulum shown in Figure 7 24 hours after commencement of a barium meal.

tissue from the pancreas and there was no difficulty in dissecting it free.

The lack of evidence is quite clearly in favor of the view that these diverticula are hernial protrusions of the bowel lining beginning at a weak spot in the muscularis. The point is being labored somewhat for it is the key to the pathogenesis and unless one is fully prepared to accept this view what follows is not tenable.

The formation of any type of hernia, depends upon the interworking of two factors (a) an area of diminished resistance in the wall enclosing the cavity from which the hernia arises and (b) pressure inside this cavity.

Areas of diminished resistance are furnished in the duodenum by the piercing of its muscular wall by the bile and pancreatic ducts and by the blood vessels, and the constancy with which diverticula are associated with one or other of these structures is sufficient

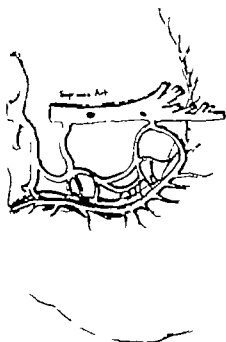


Fig. 9. The vascular supply of the duodenum. A dissection made after injecting the arteries with carmine jelly.

proof of the contention. The larger the structure piercing the wall, the more frequent should be the presence of a hernial pouch and the facts of incidence bear this out quite closely.

DUODENAL PRESSURE

The pressure inside the duodenum depends upon (a) the contents and (b) the contraction of the muscular wall.

What is the normal pressure in the duodenum? The musculature is as powerful as that elsewhere in the small intestine; therefore a high pressure during contraction is conceivable. But if the pylorus is patent, the duodenum is open at both ends, and under normal conditions of segmental and peristaltic movements the pressure is not greatly raised.

The duodenal pressure has been examined in 13 healthy patients. A radio opaque tube is swallowed by the subject until it is seen under the X ray screen to be past the pylorus. It is then connected to an ordinary water manometer, and the water levels in the two limbs compared. In all cases there was practically no difference caused in the levels except a rise and fall of from 0.5 to 1 centimeter corresponding with the respiratory excursion of the diaphragm.

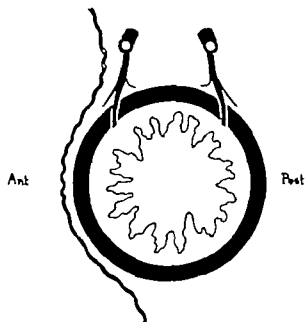


Fig. 10. The vascular supply of the duodenum. A diagram to illustrate the relation to the bowel wall of the sites of entry of the blood vessels.

If a reading could be made in this way with the pylorus closed and the duodenum contracting it is probable that greater differences in the pressure reading would result. The rapidity with which the stomach contents pass through the duodenum, as demonstrated by X ray, does not suggest that under normal conditions the duodenal contents exert any appreciable pressure upon the duodenal walls.

That under abnormal conditions at least a high pressure may occur in the duodenum is shown by the case which Figure 11 illustrates.

This remarkable appearance was discovered during the course of a barium meal in a female patient aged 62. It shows the common bile duct, the left and right hepatic ducts and even the smaller intrahepatic canaliculi filled with barium. The commencement of the cystic duct is shown, but not the gall bladder. This appearance was present in the roentgenogram taken immediately on swallowing the meal and remained until the 3 hour picture was taken. At 24 hours, the smaller canaliculi could still be seen, but the larger ducts were empty. At 48 hours the liver was clear.

This case furnishes unquestionable evidence that under abnormal conditions at least the pressure inside the duodenum may



Fig. Duodenal pressure. Entry of barium into the hepatic ducts during a barium meal.

rise to a very considerable height. Further evidence that high duodenal pressure occurs lies in the formation of ulcer diverticula; for there is no question that intraduodenal pressure plays a part in the production of these. As Perry and Shaw have pointed out, the duodenum is the only situation in the alimentary tract in which ulcers are followed by diverticula. These workers think the pylorus is largely responsible for a rise in intraduodenal pressure in opposing by its contraction an obstacle to the reflux when the lower part of the duodenum is contracting. The pressure here is greater than elsewhere in the small intestine where the fluid constituents are distributed over a greater length of bowel. In support of this theory of formation of diverticula immediately *distal* to an obstruction these authors describe a case of diverticula of the jejunum associated with a partial congenital diaphragm situated at the duodenojejunal flexure in a man of 40. The aperture in the diaphragm admitted the fifth finger and there were three diverticula meas-

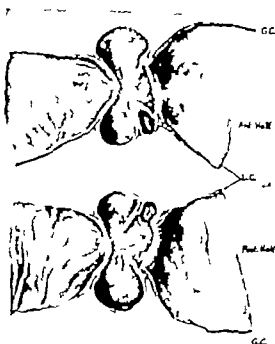


Fig. 12. The ulcer diverticula of the duodenum.

uring 1 by 1 inch on the mesenteric border of the first foot of the jejunum.

How is this high pressure produced? Not by normal segmental and peristaltic contractions, but by irregular inco-ordinated tonic contractions of the circular and longitudinal coats.

Given therefore weak areas in the bowel wall and the possibility of high pressure being caused inside the lumen of the duodenum by irregular muscular contraction an explanation of the mode of origin of these primary diverticula becomes possible.

The mucous membrane of the duodenum is forced into the interval occasioned by the passage through the duodenal wall either of the ducts or the blood vessels by the circular contractions of the duodenal muscle. In the early stages, the mucous membrane will recover its position but once started there will be a certainty of recurrence and a repetition of the event over a number of months or even years will result in a stretching of the interval between the muscle fibers, and its permanent occupation by a wedge-shaped pouch of mucous membrane. This process is easier to study both in the jejunum and the

colon, where the opportunity for observing the earliest stages arises. There can be no doubt, judging from the pathological anatomy, that this is the way that all primary pulsion diverticula start irrespective of their situation in the alimentary tract.

Once the process of mucous membrane in an intermuscular interval is established, the formation of a typical pouch is inevitable, if the patient lives long enough. The resistance to the pressure inside the duodenum is at a minimum. As the pouch is forming it carries with it muscle fibers from the bowel, the quantity varying in different cases but consisting of a very thin layer, or being entirely absent at the fundus of the diverticulum, which was the first portion to herniate. The subsequent size to which the pouch develops depends upon its age—the very large ones are nearly always found in old people—and its position. For example, those in the transverse portion of the duodenum are usually small because of the absence of any stretching force due to the weight of food contents. Those in the second part of the duodenum are probably limited in size by the support given by the pancreas, but those connected with the flexure may become relatively enormous.

In the two latter situations there is practically always a certain degree of stasis as shown by the barium meal and X ray. The failure to empty synchronously with the duodenum is due at first to the lack of an adequate muscular coat.

The high pressure to which the herniation is due is undoubtedly intermittent, and must be continued over a long period of time. Diverticula do not arise as a result of the presence of an acute obstruction to any part of the bowel.

There is an apparent paradox in this theory of development of pulsion diverticula. Both the degree of pressure and the strength of the duodenal wall depend upon the development of the muscular coat. Therefore duodena in which the muscular layer is best developed would have the most impervious wall. But the difficulty passes when it is realized that the muscular contraction which produces pulsion diverticula is an irregular one, there being areas of relaxation of the muscle coat in

tensified between the sites of tonic contraction.

The question of relaxation is an important one. If one segment of muscle is prone to enter into long periods of overaction, it should tend to hypertrophy, or at least to maintain its power. What changes may take place in a neighboring segment, which is not only relaxed for similar periods of time, but has exerted upon it during its relaxation an abnormal pressure generated by the contracting portion? Does it undergo a "relaxation atrophy"? That such a change is associated with diverticula of the large intestine, which are morphologically identical with those of the small intestine, will be made clear from a study of specimens. The relaxation area in these gives a mirror image picture of the neighboring contraction area. Such a relaxation atrophy, should it occur as I believe it does, would explain the ease of formation and progressive increase in size of the diverticula.

The presence of rugæ in some of these diverticula is not inconsistent with the theory of pulsion, for the causal pressure is an intermittent one, and Grey Turner's case of duodenal diverticulum in a woman of 60 in which the mucous membrane was thrown into folds, is not necessarily contrary evidence.

THE RELATION BETWEEN DIVERTICULA AND VISCEROPTOSIS

In many cases X rays show the presence of varying degrees of visceroptosis in subjects with duodenal diverticula, and it has been suggested that in this condition the vessels and bile ducts cause traction upon the intestinal wall, and tend to pull up the mucous membrane through the muscle coat. There may be some truth in this theory with regard to the formation of diverticula in the jejunum, but it is improbable that the duodenum reacts in this way as its comparative fixity to the posterior abdominal wall protects it from sharing in the visceroptotic process except in the severest cases.

The view that mucosal hernias are more likely to occur in the subjects of visceroptosis because of the 'atonicity' and consequent weakness of the bowel wall found in this condition can be entirely discounted. There is

abundant evidence to show that abdominal ptosis bears no relation to the condition of the muscular wall of the hollow viscera.

A possible predisposing cause of increased pressure in the duodenum occasioned by visceroptosis is constriction of the transverse portion by the superior mesenteric vessels. That this is not of very great importance though possibly a contributory factor in some cases is shown by lack of association between ileus of the duodenum and diverticulosis. This lack of cause and effect between chronic ileus and diverticulosis may appear to be evidence against the pulsion theory. This is not the case however. The facts merely show that diverticula do not arise solely as a result of passive pressure of contents upon the intestinal wall.

ACQUIRED DEGENERATION OF THE MUSCLE COAT

Is a primary local degeneration of the muscular wall a factor in producing a locus minoris resistentie? Inflammation of the muscle coat leading to atrophy has been cited as a cause but there is no histological evidence of this. Further the constant situation in the concavity of the duodenum would not be found if such were the case. Senile atrophy is another hypothesis but one which is readily discounted. Emphatically duodenal diverticulosis is not a disease of old age but of early middle age. It is true that postmortem evidence suggests its greater frequency in the aged but the fallacy of this has already been pointed out. It is true too that generally speaking the older the subject the larger the diverticulum. But this is to be expected. The diverticulum tends always to get larger and the older it is the larger it will become.

THE ULCER DIVERTICULUM

Ulcer diverticula form a distinct group. In contradistinction to primary diverticula the ulcer diverticulum is found more readily at operation or at postmortem than by X ray. At postmortem examination the one thing that may easily be missed is not the diverticulum but the healed ulcer which was responsible for it. All that is to be seen, in most cases is a minute smooth whitened area of mucous membrane adjacent to the diver-

ticulum. The opened duodenum must be examined in a good light, if necessary with a lens. The smallness of the visible ulcer is well shown in the accompanying illustration made from a postmortem specimen. In this the artist has, for the sake of clear definition, purposely accentuated the appearance of the ulcer scar. It will be appreciated therefore, how easily such scars may be missed at post mortem examination.

The only other type of diverticulum which occurs in the first part of the duodenum is the true congenital type and this is so excessively rare that one can safely work on the assumption that if a diverticulum is found in the first part of the duodenum there too will the scar of an ulcer be found.

Morbid anatomy. Both the diverticula and the ulcers may be multiple. In 7 postmortem specimens, the numbers were as follows:

- 1 2 cases with 1 ulcer and 1 diverticulum.
- 2 1 case with 2 ulcers and 1 diverticulum.
- 3 2 cases with 2 ulcers and 2 diverticula.
- 4 1 case with 2 ulcers and 3 diverticula.
- 5 1 case with 2 ulcers and 4 diverticula.

Each diverticulum consists of all four layers of the normal duodenum and the peritoneal coat is free and smooth. The mouth is well defined and bounded by a definite ridge of mucous membrane, and the lining of the pouch is smooth. There is no inflammatory process in its wall and the associated ulcer lies at some distance from its edge, and not in the floor or wall. The following is selected as a typical example.

Specimen 6 (Fig. 12). The pyloric end of the stomach and the duodenum have been divided into halves. The lesser curvatures lie next to one another in the illustration.

One-half to three-quarters of an inch distal to the pylorus are two scars of healed ulcers, occupying the anterior and posterior walls of the duodenum, respectively. Just distal to the ulcers is a prominent fold consisting of the whole thickness of the wall encircling the duodenum. Between this fold and the pylorus, the duodenum is pouched out. The pouch on the lesser curvature is subdivided by a well marked fold, again consisting of the whole thickness of the duodenal wall, into two compartments. The mucous membrane lining the pouches is smooth, and their walls are somewhat thinner than that of the rest of the duodenum, but there has been no interference with the muscle coat.

EDWARDS DIVERTICULA OF THE DUODENUM

Pathogenesis The mode of formation of these diverticula is well illustrated by this specimen. The duodenum has been shortened by contraction of scar tissue of the healed ulcers so that the wall of the duodenum is occupied by the ulcers has been puckered up and ballooned outward by intraduodenal pressure to form diverticula. In this case the maximum contraction has taken place in the direction of the long axis of the bowel.

The diverticula are produced by contraction of scar tissue and not by yielding of a weak area in the wall caused by ulceration. The latter probably never occurs. The dense fibrosis produced by the healing of a peptic ulcer would be the last place for the duodenal wall to give if subjected to pressure. In this view, the author is at variance with those expressed in the literature, in particular by Thorek and F. C. Turner both of whom describe diverticula caused by yielding of an ulcer, and describe cases in which the floor is formed by an ulcer crater. Such cases are to be regarded not as diverticula but as a part of the process of destruction of a large penetrating ulcer. A third type is described in which an ulcer is associated with a pulsion diverticulum of the second part. The part if any played by the ulcer in the formation of a perivateren diverticulum is little understood, and therefore the association of the two is best regarded as accidental.

The amount of shortening of the duodenum caused by the contraction of scar tissue is considerable especially in the specimen described where the unaffected portion of the duodenum is so ballooned out. In this case the shortening by actual measurement is 3.6 centimeters on the greater curvature side.

That pressure plays a part albeit a subsidiary one in the production of these diverticula is shown by the lack of rugae on the floor in nearly all the cases. In no case is there any gross deficiency in thickness shown. The slight difference in the diverticula and in some cases between the diverticula and the duodenal wall is due to attrition following the prolonged effect of intraduodenal pressure. But another explanation is possible. The normal contracting power of the duodenum is impeded by the fixed deformity due to the

ulcer, and there may therefore be a disuse atrophy of the muscular wall in the region of the deformity. It is probable that the persistent spasm of muscle associated with ulcers plays a part by helping to create the deformities, which are subsequently fixed by the scar contraction.

Whatever be the true nature of this minor degree of thinning of the muscle coat, the point which the author wishes to make quite clear is that the diverticula are due primarily to puckering of the duodenum due to scar tissues and the effect of intraduodenal pressure is of secondary importance.

These diverticula differ therefore in situation morphology and pathogenesis from the primary pulsion type met with in the second and third parts of the duodenum.

TRACTION DIVERTICULA

In the series of 31 cases of duodenal diverticula diagnosed by X-ray there are 2 examples of diverticula caused by the contraction of scar tissue adherent to the wall of the duodenum. In one of these the diverticulum is situated near the flexure, and is caused by involvement of the duodenal wall in the healing process of an ulcer of the lesser curve.

The second case occurred in a woman patient of 73 and was confirmed at operation. The gall bladder was thick and fibrotic, and densely adherent to the junction of the first and second parts of the duodenum, the wall of which was pulled out by the adherent gall bladder to form a small pouch.

Perry and Shaw describe a similar case. In a patient with chronic cholecystitis the wall of the duodenum was adherent to the liver, and drawn by adhesions into the form of a narrow pointed cul-de-sac. In a second case of these authors, a gall stone was found in a pouch on the right wall of the duodenum midway between the pylorus and the papilla. The pouch was adherent to a shrunken and fibrosed gall bladder. The case suggests the formation of a traction diverticulum, with later a cholecystoduodenal fistula which allowed the gall stone to enter the pouch the opening healing after this had taken place.

That traction upon the common bile duct might pull up the wall of the duodenum into

abundant evidence to show that abdominal ptosis bears no relation to the condition of the muscular wall of the hollow viscera.

A possible predisposing cause of increased pressure in the duodenum occasioned by visceroptosis is constriction of the transverse portion by the superior mesenteric vessels. That this is not of very great importance though possibly a contributory factor in some cases is shown by lack of association between ileus of the duodenum and diverticulosis. This lack of cause and effect between chronic ileus and diverticulosis may appear to be evidence against the pulsion theory. This is not the case however. The facts merely show that diverticula do not arise solely as a result of passive pressure of contents upon the intestinal wall.

ACQUIRED DEGENERATION OF THE MUSCLE COAT

Is a primary local degeneration of the muscular wall a factor in producing a locus minoris resistentiae? Inflammation of the muscle coat leading to atrophy has been cited as a cause, but there is no histological evidence of this. Further the constant situation in the concavity of the duodenum would not be found if such were the case. Senile atrophy is an other hypothesis, but one which is readily discounted. Emphatically duodenal diverticulosis is not a disease of old age but of early middle age. It is true that postmortem evidence suggests its greater frequency in the aged but the fallacy of this has already been pointed out. It is true too that generally speaking the older the subject the larger the diverticulum. But this is to be expected. The diverticulum tends always to get larger and the older it is the larger it will become.

THE ULCER DIVERTICULUM

Ulcer diverticula form a distinct group. In contradistinction to primary diverticula, the ulcer diverticulum is found more readily at operation or at postmortem than by X ray. At postmortem examination the one thing that may easily be missed is not the diverticulum, but the healed ulcer which was responsible for it. All that is to be seen in most cases, is a minute smooth whitened area of mucous membrane adjacent to the diver-

ticulum. The opened duodenum must be examined in a good light, if necessary with a lens. The smallness of the visible ulcer is well shown in the accompanying illustration made from a postmortem specimen. In this the artist has, for the sake of clear definition, purposely accentuated the appearance of the ulcer scar. It will be appreciated therefore, how easily such scars may be missed at post mortem examination.

The only other type of diverticulum which occurs in the first part of the duodenum is the true congenital type and this is so excessively rare that one can safely work on the assumption that if a diverticulum is found in the first part of the duodenum there too will the scar of an ulcer be found.

Morbid anatomy. Both the diverticula and the ulcers may be multiple. In 7 postmortem specimens, the numbers were as follows:

1. 2 cases with 1 ulcer and 1 diverticulum.
2. 1 case with 2 ulcers and 1 diverticulum.
3. 2 cases with 2 ulcers and 2 diverticula.
4. 1 case with 2 ulcers and 3 diverticula.
5. 1 case with 2 ulcers and 4 diverticula.

Each diverticulum consists of all four layers of the normal duodenum and the peritoneal coat is free and smooth. The mouth is well defined and bounded by a definite ridge of mucous membrane, and the lining of the pouch is smooth. There is no inflammatory process in its wall and the associated ulcer lies at some distance from its edge and not in the floor or wall. The following is selected as a typical example.

Specimen 6 (Fig. 12). The pyloric end of the stomach and the duodenum have been divided into halves. The lesser curvatures lie next to one another in the illustration.

One half to three-quarters of an inch distal to the pylorus are two scars of healed ulcers, occupying the anterior and posterior walls of the duodenum, respectively. Just distal to the ulcers is a prominent fold consisting of the whole thickness of the wall encircling the duodenum. Between this fold and the pylorus, the duodenum is pouched out. The pouch on the lesser curvature is subdivided by a well marked fold, again consisting of the whole thickness of the duodenal wall, into two compartments. The mucous membrane lining the pouches is smooth, and their walls are somewhat thinner than that of the rest of the duodenum, but there has been no interference with the muscle coat.

- 37 HARRISON Observations on Diseases of the Alimentary Canal, Lond. 1857 145.
- 38 HARRIS O Review of Literature. Ergebn d Chir u Orthop, 1930, 53 76
- 39 HARTLEY Tr Path. Soc. Lond. 1857 8 235
- 40 HARTUNG Radiology 1925 4 508.
- 41 HEACOCK, C. H. South M J 1920, 22 348
- 42 HODDY, G. P. B. Lancet 1923, 2 327
- 43 HUNT and HERRST Surg Clin. N America 1925 5 807
- 44 HURST A. F. Guy's Hosp Rep 1920 70 420
- 45 JACKSON C. M. J Anat. 1905 42 219
- 46 JACQUELIN and QUÉNU Bull. et méém Soc nat de chir, 1927 53 216
- 47 KALDOR, J. Ann Surg 1929, 89 6
- 48 KAMPMILLER, R. H. Am. J. B. Sc 1926 172 590
- 49 KITTIN, SIR ARTHUR. Brit M. J 1910 1 376
- 50 KOLCHOW V Zentralbl f Chir, 1928, 55 2955
- 51 KROCHER, A. Deutsche Ztschr f Chir 1927 200 273.
- 52 LAXIMORE and GRAMM. Surg Gynec & Obst 1927 45 257
- 53 LEFÈVRE and JOSCHIKES. J de méd de Bordeaux, 1926 103 648
- 54 LEWIS, D. J. Am. M. Ass 1921 76 783
- 55 LITTMAYER, H. Verhandl d. deutsch path. Gesellsch 1914, 17 445.
- 56 LOCKHART R. H. Yale J Biol Med 1931 3 505
- 57 LOCKWOOD, A. L. Transactions of the Active and Resident Physicians of the Mayo Clinic, 1930 10 54.
- 58 LUND F. B. New England M J 1928, 103 986
- 59 MACLEZOWIE, H. N. Ann Surg 1921 74 96
- 60 MIVLEAM M. J. Ann. Surg 1927 85 73
- 61 Idem. Surg. Gynec & Obst 1923 37 6
- 62 McQUAY R. W. Ann Surg 1929 89 36
- 63 MONNARRAT, K. W. Brit. J Surg 1926 14 179.
- 64 MOORE, E. C. Arch Surg., 1920, 1 513
- 65 MOORE, N. Tr Path Soc. Lond 1884, 35 202
- 66 MORCAONI. Seats and Causes of Disease, London, 1769, Book 2 Letter 34, Art. 17 Letter 37 Art. 25
- 67 MORRISON and FELDMAN Ann Clin Med., 1925 4 403
- 68 MOYNDIAN B. G. A. Duodenal Ulcer London, 1912, 268.
- 69 MURCHISON D. R. J. Am. M. Ass 1920, 75 1329
- 70 NADEL, G. W. Arch Surg, 1925 11 529
- 71 ODKER, P. N. B. Brit J Surg 1930 17 592
- 72 PENDERGRASS, R. C. Am J Surg 1928, 5 491
- 73 PENSHALLOW J. Am. M. Ass 1923, 80 1372.
- 74 PERRY and SHAW Guy's Hosp Rep, 1893, 50 171
- 75 PILCHER, L. S. Ann. Surg 1894, 2 63
- 76 RITCHIE and McWHORTER Surg., Gynec. & Obst., 1917 25 485
- 77 ROLLENTON and FEXTON J. Anat. & Physiol., 1900 35 110
- 78 ROTH M. Arch f path. Anat 1873 56 179
- 79 SCOTT S. G. Brit. M. J., 1931, 1 246.
- 80 SPENCER and MARCKER Brit J Surg 1920 8 2.
- 81 Ibid. 1921 8 18
- 82 Idem. Quart J Med., 1925 10 1
- 83 TANDLER Morphol Jahrb Leipzig, 1902 29 187
- 84 THORCK, M. Illinois M J 1920 55 64
- 85 Transactions. Section Rad Am M Ass 1927 p. 208.
- 86 TURNER F. C. Tr Path. Soc. Lond, 1884, 35 200.
- 87 TURNER, G. GREY. Lancet, 1920 1 151
- 88 VORHAUS, M. G. J. Am. M. Ass, 1930 94 165.
- 89 WILKE, K. Frankfurt Ztschr f. Path. 1929 89 6
- 90 WILLIE, D. P. D. Edinburgh M. J., 1913 11 219.
- 91 YULE E. J. Anat 1926-1927 61 344

THE MECHANISM BY WHICH THE ACIDITY OF AN ACID MEAL IS REDUCED IN THE STOMACH

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THE acid meal, since its introduction by Boldyreff has been used rather extensively in experimental studies on the stomach and has also been employed by several observers in clinical investigations. It consists of from 100 to 300 cubic centimeters of 0.3 per cent to 0.5 per cent hydrochloric acid and may be administered either by mouth or more commonly by means of a stomach tube. This type of meal is emptied out of the stomach somewhat more slowly than water and the stronger the acid is, the more the emptying time is prolonged.

When an acid meal of this character is introduced into the stomach and withdrawn 15 minutes to one-half hour later it is found that the acid during its sojourn in the stomach has been reduced in strength. This reduction is considered by most observers to be due to neutralization of the acid by (1) mucus secreted by the stomach (2) regurgitated fluid from the duodenum, consisting of bile pancreatic juice and succus entericus. With reference to the first suggested cause of the reduction the gastric mucus we (12) have shown by studies on pouches prepared from the entire pyloric region of the stomach of dogs, and also by unpublished investigations on pouches which we prepared from the entire stomach, that the amount of gastric mucus available is not sufficient in quantity nor alkaline enough to account for any significant amount of the reduction noted. The most important factor concerned in reducing the acidity of an acid meal is thus not intragastric, but extragastric; it is the fluid which comes from the duodenum into the stomach.

That this regurgitation of duodenal contents is a common occurrence both in man and in experimental animals has been noted by various observers for many years. Thus in 1909 Ehmman and Lederer noted considerable regurgitation in the Ewald Boas test meal. Ehrenreich, in 1912 found that trypsin

was present in the gastric contents of more than 50 per cent of 61 patients who were suffering from various gastro-intestinal disorders. Medes and Wright tested the contents of the stomach for 3 constituents of the duodenal fluid—bile, trypsin, and sucrose—and found evidence of duodenal regurgitation in all of 23 patients examined. Trypsin was most commonly found, often in the absence of bile, but bile was rarely present without trypsin. Spencer and his coworkers also found a tryptic enzyme to be present in the fasting or resting stomach in nearly all tests. The amount of bile as estimated by the color of the fluid, varied considerably but when the amount of bile was high the amount of trypsin was also increased.

Using the X-ray and an opaque meal, Bolton and Salmond examined 100 persons and actually saw regurgitation in 6. In the 94 remaining they saw antiperistalsis in the duodenum which they considered should be capable of causing regurgitation. Hicks and Visher in X-ray studies, noted rings of constriction and segmental contractions in the duodenum and believed that these could force the duodenal contents back into the stomach if the pylorus were relaxed. These observers also introduced 150 cubic centimeters of 0.5 per cent hydrochloric acid into the stomach and found evidence of regurgitation in 38 per cent of 56 trials in dogs, and 40 per cent of 10 trials in man. They determined the presence of regurgitation only by the presence of bile as they did not consider that much duodenal content could be present in the stomach without it.

It is evident from a consideration of the above data obtained by various methods and by several different workers, that duodenal regurgitation is a factor which must be accepted. It is true that when one uses an acid meal instead of a non-acid meal of the Ewald type there is more regurgitation. In fact as the strength of the acid is increased there is, as

pointed out by Morse and by Medes and Wright, some increase in the amount of regurgitation. Indeed, this fact is one which gives the acid meal a unique value since it gives one an index as to the capacity of the individual to regurgitate duodenal contents and lower excess acidity in the stomach.

With regard to the mechanism by which the reduction of acidity is accomplished however, there is considerable difference of opinion. The mere fact that the acid has been reduced in strength is not proof that it has been neutralized, since another factor that of dilution must be taken into account. The preponderance of opinion at present is that neutralization brings about most of the reduction. Thus Olch attributes greatest importance to neutralization of the acid by regurgitated pancreatic juice. Elman insists that the amount of duodenal fluid necessary to dilute the acid meal is too great for the duodenum to secrete. He points out that to reduce the acid from 140 to 35 (total acidity) 3 volumes of neutral fluid would be necessary whereas only $\frac{3}{4}$ volume of pancreatic juice would be required. He found that using the "alter cursive" method, little reduction occurred when the pancreatic juice was drained outside the body but when the pancreatic juice was allowed to flow into the duodenum again reduction became normal. Ortner on the other hand, believes that dilution alone could account for the reduction noted.

In order to investigate the relative importance of dilution and neutralization we utilized a method of determining the amount of dilution which was first described by Gorham and which we have already used extensively in studies on gastric acidity. The method consists, essentially in adding to the acid test meal a coloring matter so that when dilution occurs the color will decrease in intensity in direct proportion to the dilution. For this purpose phenolsulphonphthalein serves admirably since it is not absorbed by the stomach, and after it has been alkalinized, changes in its color can easily be read on a colorimeter. Details of the method and procedure used are as follows.

The experiments were performed in all cases on healthy dogs about 24 hours after

the last feeding. A stock solution was prepared which consisted of 1,100 cubic centimeters of approximately tenth normal hydrochloric acid in which 12 milligrams of the sodium salt of phenolsulphonphthalein had been previously dissolved. The stomach was first lavaged with some of this solution in order to remove any fasting contents or mucus and then the test meal, which consisted of 300 cubic centimeters of the acid phenol sulphonphthalein stock solution, was introduced. Samples were withdrawn from the stomach every 15 minutes for one hour or as long as any fluid could be obtained. A portion of each sample and a portion of the original test solution were centrifuged, alkalinized by the addition of 1 cubic centimeter of a saturated solution of sodium hydroxide for each 10 cubic centimeters of the sample, and then centrifuged again. The phenolsulphonphthalein concentration of each sample was then determined by means of a colorimeter, using the alkalinized portion of the original test solution as a standard. In the occasional instances in which mucus interfered with the reading by causing turbidity the mucus was precipitated out by the addition of sodium tungstate and sulphuric acid.

The strength of the acid in the acid meal before its introduction into the stomach, and in the fractions removed from the stomach was determined by chemical analysis since it was found that this method gave a more uniformly accurate result than titration. The acid chloride content of the test solution was determined directly, but in the samples removed from the stomach it was necessary to determine the total and neutral chloride, the acid chloride being the difference between these two figures.

The phenolsulphonphthalein reading indicates the percentage concentration of the original acid test solution which is present in the sample removed from the stomach. Consequently the phenolsulphonphthalein reading multiplied by the chloride concentration of the original acid solution gives the acid chloride concentration which would be present in the sample at that dilution if no neutralization has occurred. The acid chloride content of the sample has actually been determined,

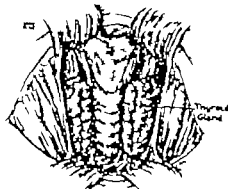


Fig. 3. The isthmus has been removed and the cut ends of the gland sutured. This is rarely possible owing to the woody firmness of the gland.

have seen occur with removal of the thyroid isthmus for constrictive symptoms.

The removal of the thyroid isthmus, as shown in Figure 1 b breaks the connection between the two lobes of the thyroid gland and gives immediate relief from pressure symptoms. When however the prethyroid muscles are sutured together over the face of the gland, the two separated lobes tend either to pull together or to be joined by scar tissue (Fig. 1 a and c) thus re-establishing and intensifying the constrictive effect upon the trachea of the encircling, chronically inflamed thyroid gland. Due to the fact that a good sized segment of the constricting ring of organizing thyroid tissue has been removed and the ends are allowed to re-establish their connection this encircling ring of thyroid tissue has been markedly narrowed and, because of this, effectually causes greater tracheal constriction (Fig. 1 c). As the result of such an operative procedure we have seen the tracheal caliber further narrowed to the size of a millet seed so that the patient could not undertake any activity necessitating increased degree of air intake. I have employed this simple operative step (Fig. 4) to prevent possible reunion of the two cut ends of the thyroid isthmus.

If any patient with thyroiditis complains sufficiently of tracheal constriction and if a roentgenogram shows definite tracheal narrowing we remove the entire thyroid isthmus well out to the points where it enters the lateral thyroid lobes. Care is taken to separate the thyroid isthmus completely from the trachea so that after its removal the trachea is left entirely free from any adherent thyroid tissue. All bleeding over the cut ends of thyroid tissue is controlled and, if possible, the cut ends are sutured over (Fig. 3). In most cases, owing to the rigidity of the infil-

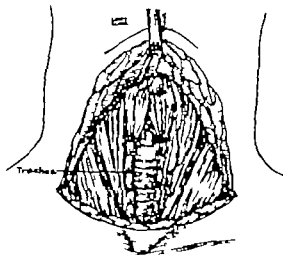


Fig. 4. The procedure herein suggested to prevent union of the two cut ends of the thyroid after removal of the isthmus. Note that all thyroid tissue has been removed from the trachea and that the sternohyoid muscles have been sutured to the trachea well out on its lateral walls so that there is a wide gap between their two bellies.

trated thyroid tissue this cannot be satisfactorily accomplished. Whether or not it can be done is unimportant if suturing of the prethyroid muscles to the lateral walls of the trachea (Fig. 4) is employed.

Fine interrupted catgut stitches can be readily passed through the fascia over the trachea without entering the lumen of that structure, and the median edges of the sternohyoid muscles can be sutured to the trachea thus covering the cut ends of the gland and interposing themselves between the cut ends of thyroid tissue so that the segments of thyroid tissue cannot reunite. Two points should be especially emphasized: (1) a wide segment of isthmus must be resected, and (2) the sternohyoid muscles must be attached to the trachea well down on its lateral walls so that a good sized gap is present between the two cut ends of the thyroid (Fig. 4). If one wishes to unite the two bellies of the prethyroid muscles so that the skin flap does not become adherent to the trachea and bob up and down on swallowing, stitches may be inserted further out in the bellies of the sternohyoid muscle and the muscles brought together after those structures have been so freed from their attachment to the sternomastoid borders that they will really displace toward the midline. This, however is usually unnecessary. The procedure described, by interposing and fixing the muscle fibers between the two cut ends of thyroid tissue establishes a gap, breaks the encircling constriction, and permanently insures against the re-establishment of the tracheal constriction.

THE CURABILITY OF MALIGNANT TUMORS OF THE UPPER JAW AND ANTRUM¹GORDON B. NEW, M.D., F.A.C.S., ROCHESTER, MINNESOTA
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IN the last two decades there has been marked improvement both in the treatment of malignant tumors of the upper jaw and antrum, and in the end results. Twenty years ago resection of the upper jaw was performed in such cases, some patients died following operation and a small number of patients remained well 5 or more years after operation. In 1920 one of us (New) reported a method of treatment of malignant tumors of the upper jaw and antrum by means of cautery and irradiation bringing out the fact that by this method of treatment operative mortality had been eliminated and the number of recurrences had been greatly reduced. Six years later a second report was made of the end results from treatment of 97 patients with malignant tumors of the upper jaw and antrum by means of surgical diathermy, cautery and radium and the fact was again emphasized that the end results revealed that more patients remained well by this method of treatment than by methods previously used.

REVIEW OF LITERATURE

The literature on this subject recently has been very carefully reviewed in a monograph by Öhngren. He traced the development of electro-surgery and irradiation in the treatment of the condition on the Holmgren service of the Sabbatsberg Clinic at Stockholm. At first, the soldering iron or *ferrum candens* was used, large electric cauteries were then developed and finally electro-surgery. Öhngren reviewed both the foreign and American literature, and his monograph is an outstanding contribution to the subject. He has evolved a clinical classification of his own for determining malignancy of the tumor in which he combines the position of the growth, with regard to whether indications for operation are favorable or unfavorable, its activity determined microscopically, and the presence or absence of metastasis. He divides the skull by means of an imaginary plane passing through the inner canthi and angles of the mandible into an anterior inferior or less dangerous portion and into a posterior superior or more dangerous portion. In turn each of these portions is further divided into

four regions: two lateral and two medial. Tumors in the medial posterior superior regions are much more dangerous and treatment is more likely to result in a smaller percentage of cures than with those in the lateral anterior inferior regions.

In England, the method of treating these tumors also has undergone evolution, as is indicated by two symposiums in the Section of Laryngology of the Royal Society of Medicine in 1922 and in 1931. In the first discussion the consensus was that these tumors should be removed by surgical cutting methods, the operative technique was stressed and the method of using cautery and diathermy was thought little of by practically all the members. In November 1931, however, the discussion revealed that the values of diathermy and of irradiation were appreciated and that resection by means of knife and scissors was little used.

A similar change in the treatment of these tumors has taken place in this country, as is indicated in articles by Sharp by Quick, and by Houser. Most radiologists, however, make an opening into the antrum for purposes of drainage only and they do not attempt to destroy the tumor when that is advisable, with surgical diathermy.

DIAGNOSIS

A diagnosis of *epithelioma of the upper jaw* when the growth originates in the mucous membrane is of course not a difficult one. At times the condition is associated with papillary leukoplakia, a condition which potentially is malignant and should be treated as such. Adenocarcinoma of mixed tumor type usually occurs posteriorly in the upper jaw and palate and as a rule presents a nonulcerated smooth, hard surface. Fresh, frozen sections should be used in all cases to make a diagnosis at the time of operation, in order to determine the type of malignancy and its activity.

Patients with a constant complaint of some pain or uneasiness in the upper jaw or in the face whose symptoms have been of short duration and who state that the pain or uneasiness has been made worse by lying down should be carefully examined to exclude malignant tumor as the cause



Fig. 1 Osteitis deformans of the upper jaw. The right antrum is involved.

of the pain. Roentgenograms should be made and careful study carried out to exclude any involvement of bone. In the indeterminate cases, with symptoms indicating a possible tumor of the antrum, it is advisable to explore the antrum above the alveolar process in order to make sure that the patient's pain is not due to a malignant condition in the antrum. This exploration should



Fig. 3 Fibrosarcoma of the right antrum and upper jaw.



Fig. 2 Giant cell tumor of the right antrum.

be carried out by the surgeon who is equipped to take care of the condition. If it is found to be malignant, thus avoiding the necessity for two separate operations, first, exploration and biopsy and then, later, a second operation in which the malignant condition is cared for. Trauma associated with such a preliminary exploratory operation usually adds to the difficulties in determining the extent of the tumor at the second operation, and it is in these cases that recurrence is most likely to take place (Figs. 1 to 6).

In the differential diagnosis of malignant tumor of the antrum, one must consider giant cell tumor, osteitis deformans, fibroma, adamantinoma, benign cyst, and osteoma. The roentgenogram is a great aid in determining, before operation, the type of tumor and its extent.

CASES STUDIED

We are presenting a study of 295 patients with malignant tumor of the upper jaw and antrum, who were operated on prior to January 1, 1929, in order to determine the curability of these tumors. There were 141 tumors of the antrum, of which 91 apparently were primary and 50 apparently secondary, and 154 tumors of the upper jaw. The division between primary and secondary tumors of the antrum is not absolute, since difficulty arose at times in determining whether the tumor originated in the jaw or in the antrum; the division is important, however, because of the difference in prognosis in the two groups.



Fig. 4. Fibro-osteoma of the left antrum and upper jaw

Of the 91 primary malignant tumors of the antrum, 63 were squamous cell epitheliomata, 6 adenocarcinomata, 7 round cell sarcomata, 9 fibrosarcomata or osteosarcomata, 3 lymphosarcomata, 2 malignant tumors of undetermined cell type, and one was a myxosarcoma. The tumor was situated on the right side in 42 cases and on the left side in 49 cases, 46.2 and 53.8 per cent, respectively.

Of the 50 secondary malignant tumors of the antrum, 30 were squamous cell epitheliomata, 5 adenocarcinomata, 11 malignant tumors of undetermined cell type, 2, fibrosarcomata, 1 was a round cell sarcoma, and 1 a myxosarcoma. The tumor was situated on the right side in 25 cases and on the left side in 25 cases.

Distribution by age and sex. Of the 91 patients in the group with primary malignant tumor of the antrum, 48 were men and 43 were women, an approximately equal distribution between the sexes. The average age of the men in this group was 46 years and of the women 49 years. Of the 50 patients with secondary malignant tumor of the antrum, 44 were men and only 6 women, or 88 per cent compared to 12 per cent. The average age of the men in this group was 53 years and of the women 39 years. Of these 141 patients with primary or secondary malignant tumor of the antrum, 92 were men and 49 women, 65.2 per cent compared to 34.8 per cent. The average age of the men in both these groups was 49 years and of the women 47 years.

Malignant tumors of the upper jaw occurred approximately three times as often among the

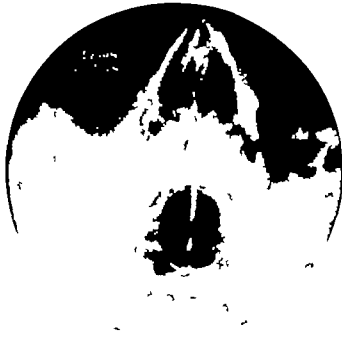


Fig. 5. Fibrosarcoma of the left antrum

men in this group as among the women, 74 per cent, compared to 26 per cent. Of the 154 patients in the group, the average age of the men was 54 years and of the women 44 years.

Of the 295 patients in the series, 206 were men and 89 women, 69.8 per cent compared to 30.2 per cent. The average age of men in the series was 52 years and of women, 46 years.

Treatment. The selection of cases for operation is based on the situation and extent of the growth,



Fig. 6. Epithelioma of the left antrum.

TABLE I—SURVIVAL AFTER OPERATION FOR VARIOUS CONDITIONS

Condition	Underwent operation			Lived after operation		
	Free	Patients	Traced	Patients	Percent of traced patients	1 case
Antrum	20	91	75	30	40	5 of 30
		5	49		5	14 of 49
	9		7		3.5	1 of 7
	20	10		3	33.4	5 of 30
			5		34.5	0 of 5
Secondary malignant tumors			8		44.9	5 of 30
		09	8		25.6	0 of 30
		7	30	7	24	0 of 30
			8	7	6.7	5 of 30
			60	25	43.4	14 of 30
Including involvement of palate		66	40	3	33.5	3 of 30
	19	90		7	63.3	5 of 30
			5	27	49	13 of 30
	9	10			40.6	5 of 30
	20	8	3		20.7	5 of 30
Malignant tumors of upper jaw					7	0 of 30
			9		66	5 of 30
		20	91	49	39.6	0 of 30
		8	5	6	66.8	5 of 30
	20	20	26	7	13.8	5 of 30
Primary and secondary malignant tumors of upper jaw and antrum		97	50	5	34.7	13 of 30
			69	30	29	5 of 30

the type of tumor and the presence or absence of metastasis, and in addition the patient's general condition and ability to return for observation. These patients should be followed up carefully after operation so that if the growth recurs they can be treated immediately. Patients with extensive primary antral tumors of highly malignant type have a better chance of recovery than those with tumors of the same size but of a low grade of malignancy so that patients with very extensive, squamous cell epitheliomata, graded 4, or with sarcomata are treated.

The treatment of tumors of this type has been outlined by us in previous reports. In most of our cases anesthesia is by intratracheal administration of nitrous oxide the tumor as a rule being approached through the mouth above the alveolar process or through the palate depending on its situation. Biopsy is made and a fresh frozen section is examined microscopically to determine

the type of growth. In addition, lateral rhinotomy may be employed an incision is made lateral to, and below the nose, a portion of the nasal bone removed and the growth destroyed through this approach. In the treatment of lesions of low grade, the aim is to destroy the tumor completely with diathermy and with the more highly malignant tumors to establish thorough drainage by means of destruction by diathermy. radium is then inserted if it is required. A protected endotherm point with the spark gap almost closed, is used in approaching the more dangerous regions about the orbit or the ethmoid bone, whereas a large point with the spark gap well open, is employed in regions wherein wide destruction will not be of any serious consequence. Preliminary ligation of the external carotid artery is not done as a routine measure but is employed only in an occasional case in which secondary bleeding necessitates its use.

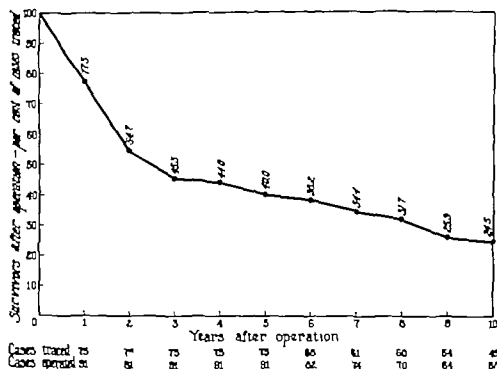


Fig 7 Survival after operation for primary antral malignancy

Postoperative observation every month or 6 weeks is advisable in cases of malignant tumor of the antrum. Sequestra are removed as soon as they tend to loosen. A vulcanite dental plate is used to close the postoperative opening in the upper jaw and is much preferable to a pedicled flap brought in from the neck. It is difficult to get a dental plate with artificial teeth that fits satisfactorily over the flap used to close a large postoperative opening in the jaw. Postoperative perforations in the cheek or nose which occur in a small group of patients, are best closed by tubed flaps brought up from the neck and thorax. In most cases it is necessary to line the flap with a full thickness skin graft in order to obtain a double layer of epithelium and to get a flat graft. We prefer to raise a flap with the upper end in the supraclavicular region and the lower end extending down over the thorax. After delaying it the distal end is carried to the mastoid region and at the next stage, the proximal end in the region of the clavicle which has been lined with a full thickness skin graft, is brought to the area on the face where it is required. This method eliminates the scarring of the neck that follows the use of a tubed flap in the cervical region as usually is employed. The character of the skin in the supraclavicular region is similar to that on the face and makes for a very satisfactory cosmetic result.

Results The results of treatment of malignant tumors of the upper jaw and of the antrum are

given in Table I. There was but 1 death in this series during the postoperative period of convalescence; this patient died of bronchopneumonia during an epidemic of influenza.

The results of Holmgren and Ohngren reveal 38.5 per cent (± 6.7) five year cures in 53 cases of malignant tumor of the antrum. They were able to trace all of their patients, whereas of 141 patients with primary or secondary malignant tumor of the antrum who were operated on prior to January 1, 1929, we were able to trace 118 of these; 53 were well without recurrence, which makes 44.9 per cent 5 year cures among patients who were traced or 37.5 per cent of the number operated on. Houser reported 15 cases, with 13.3 per cent 5 year cures and Peyton reported 11 cases; 2 of Peyton's patients are still living 1 for more than 5 years (Figs. 7 to 10).

Of patients with primary malignant tumor of the antrum 40 per cent of those who were traced were alive without recurrence 5 years after operation. Among patients with primary sarcoma of the antrum 72.2 per cent of those who were traced were alive without recurrence 5 years after operation. The fact that many of the growths were of low grade malignancy accounts for these results. Of patients with primary epithelioma of the antrum who were traced and the tumor graded a higher percentage of those with tumors of low grade (grades 1 and 2) were alive without recurrence 5 years after operation than were those with tumors of high grade (grades 3 and 4) 55.6

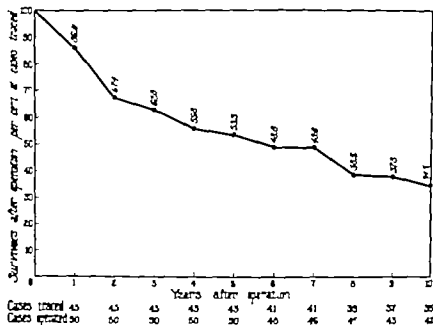


Fig 8 Survival after operation for secondary anal malignancy

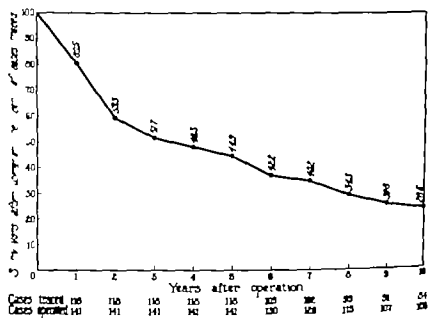


Fig 9 Survival after operation primary and secondary malignancy of the antrum, taken together

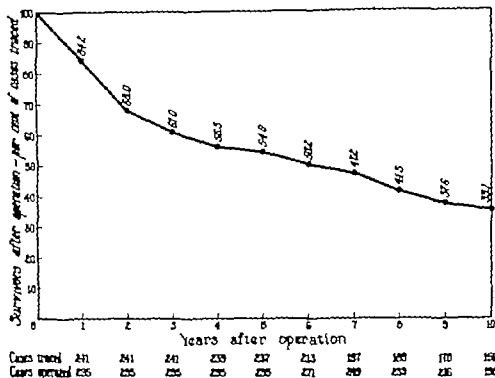


Fig. 10. Survival after operation for malignancy of the antrum and upper jaw

per cent as compared to 34.5 per cent. Of patients with primary adenocarcinoma of the antrum 33.3 per cent of those traced were alive and without recurrence 5 years after operation although these tumors are of low grade of malignancy they are not radiosensitive and complete destruction with diathermy offers the best chance of treatment. Of patients with secondary malignant tumors of the antrum 53.4 per cent of those traced were alive without recurrence 5 years after operation. These tumors originate in the upper jaw and the prognosis is better than with primary malignant tumors of the antrum. Of patients with adenocarcinoma originating in the upper jaw and involving the antrum secondarily 60.2 per cent of those traced were alive and without recurrence 5 years after operation. Of the entire group of patients with primary or secondary malignant tumor of the antrum, 44.9 per cent of those traced were alive and free from recurrence 5 years or more after operation.

Of patients with malignant tumor of the upper jaw including the palate, 62.7 per cent of those

traced were alive and free of recurrence 5 years or more after operation. Of patients with malignant tumor of the upper jaw without involvement of lymph nodes 68.3 per cent of those traced were alive and free from recurrence 5 years or more after operation whereas of those with involvement of lymph nodes only 26.7 per cent of those traced were alive without recurrence 5 years or more after operation.

Of the entire group of 295 patients with malignant tumor of the upper jaw and antrum 236 were traced and of these 127 patients or 52.8 per cent, were alive without recurrence 5 years or more after operation.

CONCLUSIONS

1. Malignant tumors of the upper jaw and of the antrum are curable.
2. Surgical diathermy and irradiation are the most efficient measures of treatment.
3. Biopsy should be made in all cases at the time of operation as an aid in determining treatment.

CONGENITAL ARTERIOVENOUS FISTULÆ OF THE EXTREMITIES VISUALIZED BY ARTERIOGRAPHY

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ARTERIOGRAPHY by means of thorotrast is a satisfactory way of visualizing arteriovenous fistula in the extremities, and it permits study of the situation and structure of such lesions before surgical exploration. The importance of the method is illustrated by the following reports, and so far as we are aware, these represent the first cases of congenital arteriovenous fistula to be studied in this manner in both cases surgical treatment was successful.

The surgical treatment of congenital arteriovenous fistula of an extremity hitherto has been extremely unsatisfactory if one can judge from reports in the literature. This is due to the fact that, in the congenital type, abnormal communication between the arteries and veins is usually multiple and for that reason extremely difficult to find at surgical exploration. According to Lewis, only 30 cases of congenital arteriovenous fistula of an extremity were recorded in the literature in 1930. In 19 of these cases, surgical exploration had been carried out in an attempt to close the fistula. This was followed by amputation of the involved extremity in 11 cases; in other words 58 per cent of the extremities found to be involved at exploratory operation were subsequently amputated (this percentage probably would be higher if follow-up information had been

available in all of the cases). Surgical cure was obtained in only one case, and that was the case reported by Lewis of a woman who had an arteriovenous fistula in the region of the right elbow. It is possible that this represented an acquired rather than a congenital arteriovenous fistula, as there was a history of an injury which was followed 2 hours later by pain and by swelling in the right elbow. Then too in this case apparently only a single abnormal arteriovenous communication was found at the time of surgical exploration.

One of us (Horton) reported 23 cases of congenital arteriovenous fistula of the extremities which were observed at the Mayo Clinic from June 28 1929 to May 11 1931. Surgical explorations were not attempted in this series of cases. However one of these patients, a man aged 44 years with a congenital arteriovenous fistula of the left leg was successfully treated following 7 injections of quinine ethyl carbamate. This patient has remained well. In addition to the case reported by Lewis, Rlenhoff in 1924, and Reid, in 1925 reported cases of congenital arteriovenous fistula, involving the vessels of the left and right sides of the neck, respectively, in which the patients were successfully treated surgically.

Every subject with congenital arteriovenous fistula of an extremity should be studied by means of arteriography before surgical exploration is carried out.

Bare reports of the 2 following cases have been given by us before the staff of the Mayo Clinic.

REPORT OF CASES

CASE 1. A man, aged 60 years, came to the clinic December 4, 1933, because of pain and swelling of the right index finger of about 2 years duration. There was no definite history of injury to the finger which could account for his symptoms. April 9, 1933, he had sustained a fracture of the distal end of the right radius, but this had healed in a satisfactory manner without fixation of motion of the wrist joint.

The only significant finding on general physical examination was the condition of the right hand (Fig. 1). The patient was of normal build and weighed 195 pounds (88.5 kilograms). The blood pressure in millimeters of mercury was 170 systolic and 103 diastolic in the right arm, and 170 systolic and 110 diastolic in the left arm. The pulse rate was 70 beats per minute. There was spotty swelling of the index finger with beginning gangrene at the tip. The veins of this finger were definitely enlarged as compared with those of other digits. The maximal surface temperature of the right hand was higher by from 2.5 to

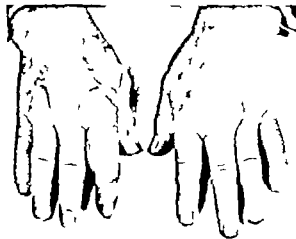


Fig. 1. The patient's hands at the time of admission. The cyanotic appearance of the right index finger can clearly be seen. The left hand was normal. (Case 1.)



Fig. 2. Arteriogram of the right hand (December 6, 1933) after injection of an opaque substance into the brachial artery. a. The arterial tree is well outlined, but the opaque medium has not entered the distal portion of the right



index finger. b. The venous tree is well outlined but that fistula in the index finger are present is evident. av, Showing the region in which the arteriovenous fistula was located (Case 1).

3 degrees C. than that of the left hand. Bradycardiac reaction could not be elicited when the right brachial artery was compressed by means of a sphygmomanometer cuff. A roentgenogram of the right hand revealed erosion of the lateral aspect of the middle phalanx of the index finger. A clinical diagnosis of arteriovenous fistula of the right index finger was made. This was confirmed by the finding of a high admixture of arterial blood in the veins of the right index finger and in those of the right hand. Blood removed under oil from a superficial vein of the right index finger and from one of the right hand, disclosed an oxygen content of 20.15 and 20 per cent by volume, respectively, whereas blood removed in a similar manner from a vein of the left hand disclosed an oxygen content of 15.6 per cent by volume. The oxygen capacity was 21.15 per cent by volume. The oxygen content and capacity of the blood were determined by the Van Slyke gasometric method. The percentage of the saturation of oxygen in the blood was calculated by dividing the oxygen content by the oxygen capacity. The patient had been at rest in a horizontal position for 30 minutes when the specimens of blood were withdrawn. The oxygen saturation of blood from the right index finger was 94.8 per cent and that from the right hand 94.6 per cent. The oxygen saturation of blood from the left hand was 73.8 per cent. An arteriogram following injection of 10 cubic centimeters of thorotrast into the right brachial artery re-

vealed evidence of an abnormal arteriovenous communication in the right index finger (Fig. 2, a and b).

The right index finger was amputated through the meta carpophalangeal joint, and the patient made a satisfactory recovery. The wound healed by primary intention. The

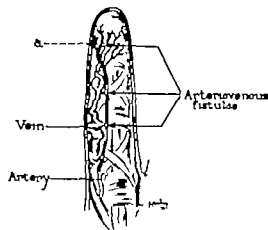


Fig. 3. A dissection of the right index finger illustrating three arteriovenous fistulae. (Case 1).

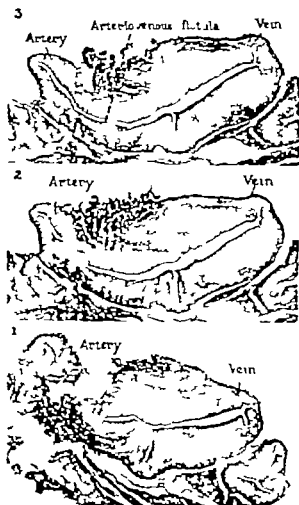


Fig. 4. Sections taken serially at point *a* in Figure 3. A direct communication between the artery and vein can be seen in the top section (Case 1).

each of the right finger were dissected, and at least 5 arteriovenous fistulae were found between one of the digital arteries and an accompanying vein (Fig. 3). Microscopic sections (Fig. 4) taken serially at a point corresponding to *a* in Figure 3 revealed direct communication between the artery and vein. The vein illustrated in this figure was large and tortuous, and there were many aneurysmal sacs along it. The walls of the veins in most of the microscopic sections were markedly thickened and these veins presented the general appearance of arteries. This was due to the fact that they were functioning as arteries.

Blood removed from veins of the right and left hands, 13 days after amputation of the right index finger, revealed the same concentration of oxygen in the venous blood of each hand. Forty-nine days after amputation of the right index finger, the systolic blood pressure in the right arm was 46 millimeters of mercury and the diastolic pressure, 30. In the left arm, the systolic pressure was 55 and the diastolic pressure 34.

We feel that the diagnosis of congenital arteriovenous fistula of the right index finger has been

established in this case. This is the oldest patient with the condition who has been observed at the clinic. Lesions of this character, when confined to a hand or foot, almost invariably manifest themselves at birth, shortly after birth, or before the age of 20 years.

CASE 2. A man, aged 40 years in 1933, was observed at the clinic in December 1926, February 1928, December, 1929 and again in December 1933. General examination has given essentially negative results at each of this patient's visits to the clinic, except for the condition in the right hand and forearm (Fig. 5). He is a strong, healthy looking individual, and routine laboratory studies have given negative results.

When he first came to the clinic a diagnosis of acquired arteriovenous fistula of the right hand was made, and the case originally was reported as an example of this condition by Carter. We are now of the opinion that this patient's condition was congenital, and one of us (Horton) included this case (as Case 22 in the table) in the report on congenital arteriovenous fistulae published in 1932. The patient thought that his right hand had been injured catching a baseball when he was 20 years of age, and he attributed later developments to this injury. A break in the skin had not been observed at that time. The sudden development of small arteriovenous fistulae in the palm of the right hand at the age of 20 years could hardly account for the overgrowth of bone in the right forearm. The bones of the right forearm were 0.5 centimeters longer than the corresponding bones of the left forearm. Increase in length of a bone occurs apparently only when a fistula has been established for considerable time before ossification of the epiphyseal cartilages takes place. It seems rather evident that this patient had had an abnormal arteriovenous communication in his right hand for a long time, and that his injury had merely aggravated the condition. The right middle finger had been amputated at the metacarpophalangeal joint in 1910, and the wound had healed promptly. On his first admission to the clinic in December 1926, it was observed that the veins in the right forearm and back of the right hand were more prominent than those of the corresponding normal hand. There was a fluctuating, bluish mass, about 2.5 centimeters in diameter at the base of the right fourth finger. This pulsated synchronously with the heart beat. No thrill was present, but a characteristic bruit was heard over the hand, and this bruit was accentuated with each heart beat. Compression of the ulnar artery caused the bruit to disappear; compression of the radial artery produced little effect on the bruit. This pulsating mass was explored by Dr. Pemberton in December 1926, and the third and fourth digital branches of the superficial palmar arch and veins of the stump of the middle finger were ligated. About 8 weeks was required for the wound to heal. The same physical signs were present after the operation as before.

There had been very little change in the appearance of the hand at the time of the patient's second and third admissions, except that the pulsating region in the palm of the hand had increased slightly in size. This increase had been particularly noticeable during the 2 years preceding his last examination. At the last examination, the bruit was more marked than on previous visits, and there was a well developed, palpable thrill in the hand. This was evident when one shook hands with the patient, and the apex beat of the heart decreased from 3 to 5 beats per minute if the hand was gripped firmly. Compression of the ulnar artery did not cause the bruit to disappear.

Blood removed from a large vein of the right forearm



Fig. 5 Appearance of the hands and arms at the time of the patient's admission in December 1933. Marked enlargement of the veins in the right hand and forearm may be noted (Case 2)



Fig. 6 Appearance of the right hand 16 days following amputation of the right fourth finger (amputation of the third finger had been performed at an earlier date) (Case 2)

in 1925 (on the patient's second visit) had an oxygen saturation of 94 per cent. At the patient's last visit, blood removed from a vein at the right elbow had an oxygen content of 90.16 per cent by volume, and blood from a vein at the left elbow 12.49 per cent by volume. The oxygen capacity was 21.17 per cent by volume. The oxygen saturation of the blood in the right arm was 95.3 per cent, and from the left arm 59 per cent. The difference in the color of the blood from the two extremities was sufficient of itself to establish the diagnosis of an arteriovenous fistula, because the blood from the right arm was bright red, indicating its arterial character whereas that from the left arm was dark red, such as one obtains from normal veins.

At the patient's first visit the roentgenogram of the right hand gave evidence of slight periarticular arthritis of the phalangeal joints, and this condition was still present at the last examination.

The maximal surface temperature of the right hand, at the last visit, was 4.7 degrees C. warmer than that of the left. The right hand liberated 101 small calories per minute, whereas the left hand liberated 92 small calories per minute. At the same visit, when the right brachial artery was compressed with a sphygmomanometer cuff the apex beat of the heart decreased from 4 to 6 beats per minute. Blood pressure in the right arm in millimeters of mercury varied from 110 to 140 systolic and from 70 to 78 diastolic. On a previous visit (1928) a systolic blood pressure of 154 millimeters of mercury had been observed in the right arm. In the left arm at the last visit, the systolic blood pressure varied from 105 to 134 and the diastolic blood pressure from 68 to 74.

An arteriogram of the right hand, made in 1933, following injection of 10 cubic centimeters of thorotrast into the right brachial artery revealed an interesting condition (Fig. 7 a and b). None of the opaque material which had been injected into the right brachial artery had entered the fingers. It had been short-circuited by way of the abnormal arteriovenous communications in the hand and had returned to the general circulation by way of the veins. One

of us (Horton) in February 1928, had observed the same phenomenon in this case following injection of 10 cubic centimeters of lipiodol into the right brachial artery.

December 21, 1933, the right fourth finger and a V-shaped portion of the palm of the right hand, including most of the third and fourth metacarpal bones, were removed surgically by one of us (Ghormley). The wound healed by primary intention in 16 days. The circulation in the thumb, index, and fifth fingers returned to normal, and the surface temperature of these digits remained essentially the same as that of the digits of the left hand (Fig. 6). Microscopic sections taken serially through the V-shaped portion of the palm of the right hand revealed many direct communications between the arterioles and venules.

The blood pressure on the first postoperative day was 142 millimeters of mercury systolic and 90 diastolic in the right arm, and 150 systolic and 65 diastolic, in the left arm. On the eighth postoperative day, the blood pressure in the right arm was 135 systolic and 75 diastolic, and in the left arm 100 systolic and 60 diastolic. At this time oxygen determinations of blood from a superficial vein at the right elbow revealed oxygen saturation of 89.9 per cent, and for blood from the corresponding vein of the left elbow oxygen saturation of 83.2 per cent. On the twentieth postoperative day the mean blood pressure in the right arm was 113 systolic and 82 diastolic, and in the left arm 117 systolic and 84 diastolic. Blood removed from a superficial vein at the right elbow on the twenty-second postoperative day was of an oxygen saturation of 81.2 per cent and that from a corresponding vein of the left elbow 77.7 per cent. It is interesting to note that the oxygen saturation of blood from the right arm was slightly higher than that of blood from the left arm following surgical amputation of the right fourth finger and excision of a V-shaped portion of the palm of the right hand. This probably indicates that the patient still had additional, small, abnormal arteriovenous communications in the right upper extremity. Bradycardiac reactions could not be elicited during this latter period of observation.

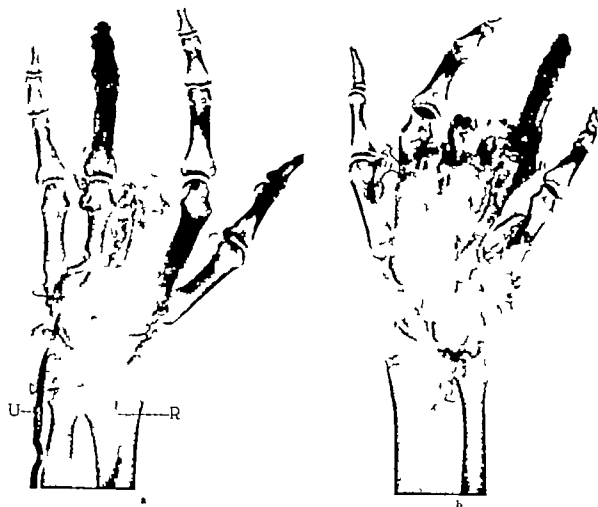


Fig. 7. Arteriogram of the right hand (December 6, 1933) after injection into the brachial artery of an opaque substance. Arteriovenous fistulae may be seen. The opaque

Since the patient's dismissal, he has written that he is able to use his right hand in plowing and routine farm work. Before the operation his hand was practically useless.

Some interesting clinical observations were made during the period of convalescence. In Case 2, teleoroentgenograms of the heart taken at the time of last admission revealed the transverse diameter to be 14.7 centimeters (Fig. 8a) but 21 days following the operation the transverse diameter of the heart had decreased to 12.6 centimeters (Fig. 8b), an actual decrease of 2.1 centimeters. It was evident that the arteriovenous fistulae in the right hand had been of sufficient size to produce systemic effects on the cardiovascular system. The blood pressure had been slightly higher in the right arm than in the left; the heart rate had been consistently more than 80 beats per

minute and when the right brachial artery was compressed by means of a sphygmomanometer cuff it decreased from 4 to 6 beats per minute. It seems probable that the chief cause of the increase in size of the shadow of the heart was dilation with a minimal amount of hypertrophy although one cannot be entirely sure of this. The decrease in size of the shadow of the heart was chiefly confined to the left ventricle, which is evident when one compares the teleoroentgenograms. This is what one would expect following surgical closure of arteriovenous fistulae such as were present in the right hand of this patient. It is interesting also to note that the total transverse diameter of the shadow of the heart in each instance was less than 50 per cent of the transverse diameter of the thorax.

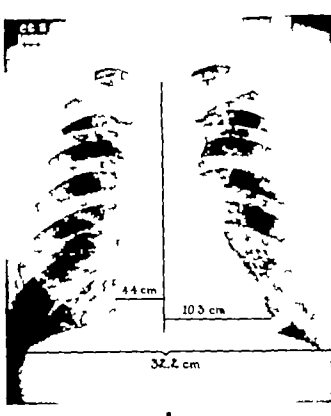
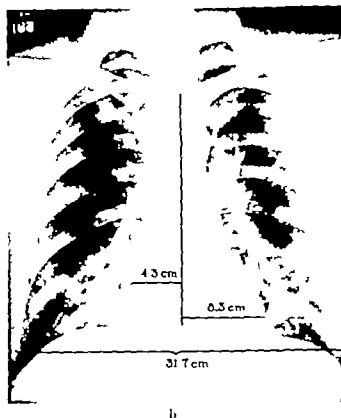


Fig. 8 a, Teleoroentgenogram of the thorax December 5, 1933, illustrating the size of the heart b, January 11,



1934, showing definite decrease in the size of the heart. The measurements are of the cardiac shadow (Case 2)

Oxygen determinations of the venous blood serve not only to determine whether the patient has an arteriovenous fistula prior to surgical exploration, but also when carried out following surgical operation, to give accurate information as to whether abnormal arteriovenous communications in the extremity have all been closed. This is a simple procedure and a valuable aid in estimating the results of operation. Without oxygen determinations of this character one would have said that a perfect cure had been obtained in Case 2. This, however, is probably not true although from all other clinical standpoints it would appear so.

SUMMARY AND CONCLUSIONS

Arteriography such as was carried out in these 2 cases offers an important means of finding abnormal communications between arteries and veins. One of us (Horton) previously has used this method to demonstrate an acquired arteriovenous fistula in the right thigh following a gunshot wound; this case has been recognized in the literature as the first in which an acquired arteriovenous fistula was visualized by means of arteriography. So far as we are aware the 2 cases herein described are the first cases of congenital arteriovenous fistula in which the condition was

visualized by arteriography. Visualization of arteriovenous fistulae in the extremities of both the congenital and the acquired types can be carried out successfully in most instances and should be of great help to the surgeon in treating such lesions. At present it is only by means of arteriography that the surgeon can learn in which cases operation will be a remedial measure. Therefore it is only by means of arteriography that additional progress will be made in the surgical handling of these vascular anomalies.

BIBLIOGRAPHY

1. HORTON, B. T. Hemihypertrophy of extremities, etc. *J. Am. M. Ass.* 1933 98 373-377.
2. Idem. Arteriovenous fistula involving the common femoral artery identified by arteriography. *Proc. Staff Meet. Mayo Clin.* 1933 8 180-191.
3. HORTON, B. T. and GHORMLEY, R. K. Congenital arteriovenous fistula. *Proc. Staff Meet. Mayo Clin.*, 1933, 8 773-776.
4. LEWIS, D. W. Congenital arteriovenous fistula. *Lancet*, 1930, 2 621-629 680-686.
5. REID, M. R. Studies on abnormal arteriovenous communications, acquired and congenital. I, *Arch. Surg.* 1925 10 601-638. II *Ibid.* 990-1009. III *Ibid.* 11 25-42. IV *Ibid.* 237-253.
6. RICHMOND, W. F. Congenital arteriovenous fistula, etc. *Bull. Johns Hopkins Hosp.* 1924 35 271-284.
7. LATER, W. M. Acquired arteriovenous fistula: report of four cases. *Ann. Surg.* 1928 87 19-31.

RESECTION OF THE KIDNEY¹

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IN view of the fact that the general tendency in the surgical treatment of various lesions of the kidney has had a distinct trend toward conservatism, and because resection of the kidney is an operation of great possibilities in well selected cases, it does seem strange that the operation has been performed relatively infrequently. In recent publications, both Young and Judd call attention to the fact that the operation is rarely performed.

With the development of modern urology and with the many problems calling for solution particularly from the diagnostic standpoint, it is not surprising that this conservative procedure should temporarily be lost sight of.

Kuester in his monograph published in 1896 collected but 30 cases that had been subjected to a resection of the kidney with a mortality of 16.6 per cent. Perhaps resection fell into temporary disrepute because of the poor results obtained when the operation was first performed. Moreover during the inceptive period of kidney resection the operation was unwisely invoked a matter clearly evidenced by the statistics of Kuester in 16 of the 30 cases, resections were either for tumor or tuberculosis. The lack of refinements of diagnosis in some of the early cases must be held responsible for the failures recorded since the operation was carried out in lesions which we now know are wholly unsuited for resection, among these lesions being malignant tumors and tuberculosis, conditions requiring a radical operation and not a conservative one.

Resections of portions of normally formed kidneys have been done for various pathological conditions and many of them were carried out long before the advent of modern urological diagnosis. Among the various lesions for which resections were done may be mentioned the following:

Spiegelberg (1870) accidentally resected an echinococcus cyst of the right kidney. Wells (1884) accidentally removed about one-third of the left kidney in shelling out a tumor in the region of the kidney. Czerny (1887) resected a tumor an angiosarcoma of the kidney. Keetley (1890) removed by lumbar incision the loose and crushed-off lower extremity of the left kidney after a wagon accident. Waitz (1891) did a resection for pyonephrosis. Bardenheuer (1891) did resections in 2 cases—one for calculus pyonephrosis the other for injury. Kummell (1893) reported 3 cases of resec-

tion—the first a localized inflammatory process (a hard nodule the size of a walnut) the second an abscess caused by a calculus the third an echinococcus disease. Block (1896) resection of a tumor of the kidney an adenoma. Moynihan (1902) reported 3 resections—(1) a solitary cyst (2) a solitary cyst in a connecting band of a horseshoe kidney (3) a tumor. Rathbun in a recent publication reported a series of six resections.

Resections of double kidneys have been performed more frequently than have resections of normally formed kidneys, but this is undoubtedly due to modern urological diagnosis. The lesions are generally infected hydronephroses with or without stone. In this connection it might be well to mention the case of Elsendorath, Philfer and Culver in which the lesion was bilateral and resection on each side was carried out.

In a discussion of resection of the kidney it is necessary to differentiate between two types: (1) resection of a part of a normally formed kidney (2) resection of one-half of a double kidney.

In this series 10 resections were done upon 10 normally formed kidneys as distinguished from double kidneys. The resections were done for the following lesions:

	Cases
Stones	5
Solitary cyst	1
Solitary cyst and stone	1
Traumatic cyst	1
Benign tumor	1
Carbonicle	1

Resection of one-half of a double kidney was done in 6 cases. It has frequently been stated that kidneys which are the seat of congenital anomalies are more prone to undergo pathological changes than are normal kidneys. The 6 resections of double kidneys were done for the following lesions:

	Cases
Hydronephrosis	3
Hydronephrosis and stones	1
Hydronephrosis and ectopic ureter	1
Hydronephrosis and stone in ureter	1

INDICATIONS

1. Whether the solitary kidney is congenital in origin or the result of a previous nephrectomy the problem of treating it when it becomes the seat of a serious lesion is the same. Among the lesions in a solitary kidney that are amenable to resection may be mentioned circumscribed collections of



Fig. 1. Pyelogram after resection in Case 1.

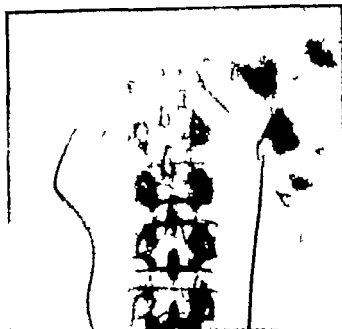


Fig. 2. Pyelogram showing the presence of a large cavity in lower pole of kidney. Stones found in this cavity. Case 2.

TABLE I.—AGES

Age in Years	Cases
Under 10	3
10 to 20	1
20 to 30	3
30 to 40	2
40 to 50	3
50 to 60	3
Over 60	1

Oldest patient, 61 years; youngest patient, 6 years.

stones, especially with infection, the presence of a stone in a calyx with dilatation and with a stricture of the neck, a hydronephrosis with more or less destruction of parenchyma and encysted stones with abscess formation that leads to destruction of the parenchyma. Naturally, when these conditions are present in one of two kidneys resection may just as well be performed.

Resection is also indicated—

2. In cases of bilateral stone in which one pole is diseased or in cases in which there exists a circumscribed stone with pus formation,

3. In cases of partial hydronephrosis of the upper or lower pole with stone formation.

4. In cases of solitary cyst of the kidney. In this group of cases resection is at present recognized as the operation of choice and, as a rule, is very simple and easy of execution.

5. In cases of double kidney with double pelvis in which one-half shows the presence of hydronephrosis, severe infection, or stone.

6. In certain cases of metastatic kidney infection that is carbuncle of the kidney. Resection in a case of this sort proved to be a very wise choice in which the opposite kidney became the seat of a carbuncle. This case (Case 10) had many interesting phases.

7. In case of poor function of opposite kidney.

In Table I is given a summary of the ages of the patients upon whom a resection of the kidney was done.

GROUP I.—NORMALLY FORMED KIDNEYS. RESECTION

Recurrent Right Renal Calculi

CASE 1. D. W. R., male, aged 46 years, was admitted to the Presbyterian Hospital, July 8, 1925. The symptoms be-

gan 22 years ago with left renal colic. The attacks would subside with the passage of gravel. Patient would then remain symptom free for a period of 4 to 5 years when another attack would occur. He also experienced attacks of colic on the right side. Twelve years later, after having received injections of oil in the left ureter, a stone passed. Two years later stones were removed from the right kidney.

For the past 5 years and up to the present admission to the hospital, the patient has complained of a pain in the right kidney region for which he sought relief.

Physical examination was negative. Urinalysis showed no sugar, no albumin, some pus. Examination of blood showed red cells 4,850,000, leucocytes 9,900, hemoglobin 88 per cent. Blood chemistry revealed urea nitrogen, 12.2; uric acid, 2.8; creatinin 1.5; non-protein nitrogen 37.2. The blood pressure was 122/72. The Wassermann reaction was negative. Roentgen-ray examination showed within the right kidney area a large, irregular, dense area, apparently a kidney stone filling the pelvis, and two shadows in the lower pole. Cystoscopic examination revealed a mild cystitis. The bladder was otherwise negative. Both ureters were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed the following:

	Leucocytes per cu. mm.	Cultures
Bladder	66	Bacillus proteus
Right kidney	1	Bacillus proteus
Left kidney	13	Strep.



Fig. 3 The peculiar shape of the stone in the lower pole of the kidney is shown. At operation a large cavity with a narrow neck was found. Case 3.

By thakem test the output was 74 per cent of the dye for 1 hour.

Operation was done July 1, 1928, under ethylene anesthesia, and consisted of (1) pyelotomy and removal of a large stone from the pelvis, (2) resection of the lower pole of the kidney. In the resected piece of kidney a very large cavity was found that contained two stones.

(The recurrent stones were probably due to the fact that when the stones were previously removed a cavity was left so that the patient again developed kidney stones.)

Result—uneventful recovery.

Subsequent X-ray examinations were negative for stone (Fig. 5).

Left Renal Calculi

CASE 2. H. W. male, aged 30 years, was admitted to the Presbyterian Hospital, June 26, 1920. Attacks of pain in the left kidney region associated with nausea and vomiting began 7 years ago. The pain radiated along the course of the ureter. No hematuria, no frequency of urination, no nocturia were noted. X-ray examination at that time showed a stone in the left ureter which the patient passed 2 weeks later. The patient had no further trouble until 2 weeks ago when he was seized with a pain over the left kidney region which lasted for 24 hours.

Physical examination was negative. Urinalysis showed no sugar, no albumin, some blood, an occasional leucocyte and many red blood cells. Examination of blood showed red cells 4,730,000, leucocytes, 12,000, hemoglobin, 85 per cent. Blood chemistry examinations showed urea nitrogen, 18.3; uric acid, 3.0; creatinin, 1.9; non-protein nitrogen, 30.7. The Wassermann test gave a negative reaction. Roentgen-ray examination revealed a group of shadows in the region of the lower pole of the kidney on the left side. Cystoscopic examination disclosed a normal bladder. Both ureters were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed:

	Leucocytes per cu. mm.	Cells	Culture	Tubercle bacillus
Bladder	30		Sterile	
Right kidney	20		Sterile	
Left kidney	20	Few granular	Sterile	

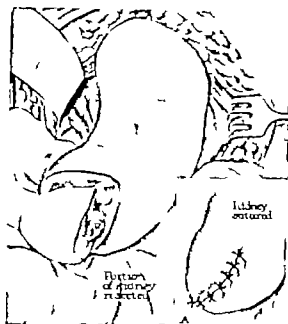


Fig. 4 A wedge shaped piece of kidney tissue containing a large cavity and a dumb bell shaped stone as resected. Insert shows the line of suture. Case 3.

Guinea pig tests—Bladder, right and left negative for tuberculosis. The left pyelogram (Fig. 6) showed a rather large pelvis, the calyces clubbed, the inferior calyx broad, not so densely filled as the rest, and with some mottling due to the stone shadows.

Operation was done July 8, 1920, under nitrous oxide and ether anesthesia and consisted of resection of the lower pole of the kidney. This contained a large cavity in which 2 stones were found.

Result—uneventful recovery.

Subsequent roentgen-ray examination showed a complete absence of the nest of calculi previously shown near the lower pole of the kidney. The last (March 16, 1934) examination showed no stone shadows.

Blood chemistry examination, May 10, 1934 showed urea nitrogen, 30; creatinin, 1.71; non-protein nitrogen 32.

Renal Calculi and Ureteral Calculi

CASE 3. Dr. P. P. male, aged 34 years, admitted to the Presbyterian Hospital, November 3, 1927. He has had attacks of bilateral renal colic extending over a period of 15 years, during which time over 30 stones were passed. The attacks were associated with frequency, nocturia, urgency, burning, and intermittent hematuria. Seven years before he came under my observation, stones were removed from the right kidney. Two years later X-ray examination showed a recurrence of stones. The attacks of renal colic and the passage of stones have continued up to the present time.

Physical examination was negative.

Urinalysis showed no albumin, no sugar, no blood, leucocytes 50 per cubic millimeter.

Blood examination revealed red cells, 4,786,000, leucocytes, 14,400, hemoglobin, 90 per cent. The blood pressure was systolic 88, diastolic 78. Roentgen-ray examination showed stones in both kidneys and two low-lying left ureteral stones.

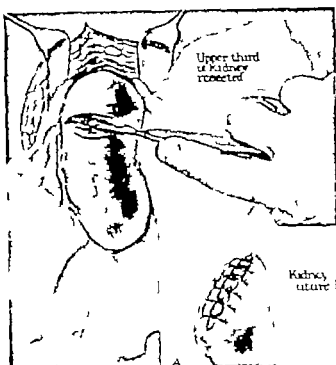


Fig. 5. Resection of the upper third of the kidney. The resected portion of the kidney contained a large cavity with multiple stones. Insert shows the line of closure. Case 4.

Cystoscopic examination of the bladder was negative. The right and left ureters were catheterized without difficulty or obstruction. The urine obtained at this time showed

	Leucocytes per cent	Cultures
Bladder		
Right kidney	4	Sterile
Left kidney	3	Sterile
	90	Sterile

Thalein test revealed a total output of 2 per cent from the right side and 5 per cent from the left side in 30 minutes. Roentgen-ray examination disclosed a large stone in the lower pole of the left kidney and 2 stones in the pelvic portion of the ureter. The stone in the kidney consisted of a very large lower part and an isthmus which was connected with a smaller part of the stone. This stone may be said to have a dumb-bell configuration (Fig. 3).

Over a period of 4 months oil injections were made through a ureteral catheter and during this time one of the stones was passed. The attacks of renal colic recurred more frequently and became more severe. Operation was advised.

On March 16, 1928, under ethylene anesthesia a ureterotomy was done and the stone removed from the left ureter. A second operation was done March 30, 1928, and ethylene anesthesia was again used. At this time the lower pole of the left kidney was resected (Fig. 4).

(It seemed to me that resection of the kidney was clearly indicated because of the large cavity with a narrow neck that would have remained if only the stone had been removed.)

Result: uneventful convalescence.

Multiple Renal Calculi (Right)

CASE 4. C. C. male, aged 13 years, was admitted to the Children's Memorial Hospital, November 9, 1932. At the

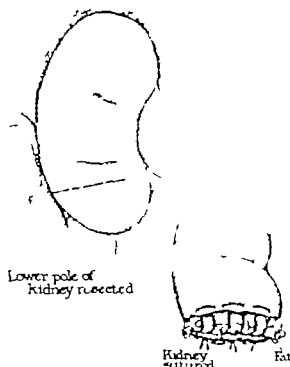


Fig. 6. Resection of lower pole of kidney. Insert shows the line of suture. Case 5.

age of 4 months the infant had entered the hospital because of difficulty and pain on urination for which a circumcision was done. When admitted to the hospital, he was suffering from an abdominal pain of the right side, nausea, vomiting and fever. At this time a diagnosis of acute appendicitis was made.

Physical examination revealed a generalized rigidity of moderate degree over the entire abdomen, but especially over the upper right quadrant, tenderness over the entire right side, and a point of severe tenderness 1.5 centimeters above McBurney's point. Urinalysis revealed albumin + acetone ++, benadine ++, 10 to 12 red blood cells per high power field, an occasional leucocyte, numerous cystin crystals, no casts, no bacteria in stained specimen. Blood examination disclosed leucocytes, 19,650, polymorphonuclears, 84 per cent, lymphocytes, 11 per cent. Roentgen-ray examination showed two stone shadows opposite the transverse process of the first lumbar vertebra on the right side. An intravenous pyelogram revealed a slight delay in visualization of the dye on the right side and dilatation of the pelvis and ureter. The kidney and ureter on the left side were normal. There was, however, an increased density of the shadows in the region of the stones in the right kidney.

Operation was done November 23, 1932, and ether anesthesia was used. The upper third of the kidney was resected (Fig. 5) and in it was found a large cavity which contained stones and it had a narrow outlet. Chemical examination of the stones showed pure cystin. Subsequent examinations of the urine during patient's stay in the hospital showed no cystin.

Result: uneventful recovery. Patient was discharged December 12, 1932.

Examination of the urine, April 27, 1933, again showed cystin crystals.

Chemical test for cystin was positive.

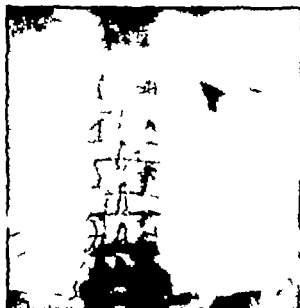


Fig. 7. Intravenous pyelogram showing deformity of the pelvis with medial displacement of the ureter and outline of the cyst. Case 6.

Multiple Kidney Stones with Dilatation of the Inferior Calyx

CASE 5. Dr H. R. male aged 39 years, was admitted to the Presbyterian Hospital, June 1, 1932. His first attack of right renal colic began 15 years ago. Subsequent attacks were severe and required morphine for relief. Following the second attack, a stone was passed. A roentgenogram 3 years ago showed three stones in the right kidney. During the past 3 years there has been a fairly constant right lumbar backache. Two or three mild attacks of chills with fever have occurred during the past 2 years and varying amounts of pus and an occasional red blood cell have been found in the urine.

Physical examination disclosed tenderness on deep pressure in the right costovertebral angle. The lower pole of the right kidney was palpable and tender. Bilateral incomplete direct inguinal hernia was noted. Urinalysis showed no albumin, no sugar, no blood, leucocytes occasional, no red blood cells or casts were seen under the microscope. Examination of blood showed red cells, 5,120,000; leucocytes, 8,600; haemoglobin, 90 per cent. The blood pressure was systolic 92 diastolic 50. Roentgen-ray examination disclosed 3 stones in the region of the lower pole of the kidney. Two of the stones were covered by the shadow of the last rib. The thallium test showed total output of dye, 56 per cent for 1 hour.

Operation was done June 3, 1932, and ethylene anaesthetic was used. Resection of the lower pole of the kidney revealed large cavity containing stones (Fig. 6).

Result and careful recovery

Subsequent roentgen-ray examination, January 6, 1933, revealed no signs of calculi at any point. The right kidney outline looked the same as in the picture of a year ago.

Blood chemistry examination, May 6, 1934, showed urea nitrogen, 14; uric acid 5.4; creatinin, 1.4; non-protein nitrogen, 33.

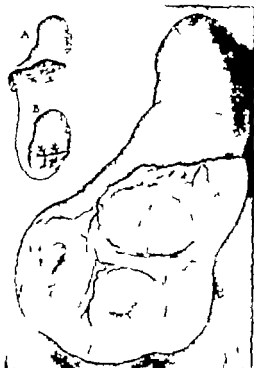


Fig. 8. Large solitary cyst springing from lower pole. Insert A shows the appearance of kidney after resection of cyst; insert B the line of closure. Case 6.

Solitary Cyst

CASE 6. Mrs E. G. aged 45 years, was admitted to the Presbyterian Hospital, June 1, 1933. In June, 1930, a vaginal hysterectomy was done, and the following October patient noticed in the left side of the abdomen at the level of the umbilicus a dull aching pain that radiated through to the back. The pain was intermittent for weeks at a time it was completely absent, and then recurred and remained constant for several days or weeks. After an interval of 2 months, during which the pain was absent, a similar attack occurred, more severe in character. There were no urinary symptoms.

Physical examination was negative except for a cystic swelling of the thyroid and an enlarged left kidney which was smooth, not tender and freely movable. The right kidney was not palpable. Urinalysis revealed no albumin, no blood, no sugar but few red blood cells present in the sediment. Blood examination disclosed red cells, 4,500,000; leucocytes, 11,000; haemoglobin, 84 per cent. Blood chemistry showed urea nitrogen, 11; uric acid, 3; creatinin, 1.4; non-protein nitrogen, 34. The blood pressure was systolic 34, diastolic 76.

Roentgen-ray examination was negative for stone. A large swelling was visible which was attached to the lower pole of the left kidney. The findings were compatible with the finding of a solitary cyst which springs from the lower pole of the kidney.

An intravenous left pyelogram showed the pelvis and calyces pushed up by the tumor mass in the lower pole so that the calyces were compressed in the medial portion and were drawn outward at the upper portion of the upper pole (Fig. 7).

Right Pyelogram—Normal

Cystoscopic Examination—Bladder normal Ureters catheterized without difficulty or obstruction Examination of the urine obtained at this time showed

	Leucocytes per cu mm	Culture
Bladder	0	Sterile
Right kidney	0	Sterile
Left kidney	0	Sterile

Operation was June 9, 1933 and ethylene anesthesia was used. The usual left lumbar incision was made. A large solitary cyst about the size of a grapefruit was found springing from the lower pole of the kidney. The cyst was resected and a nephropexy done (Fig. 8).

Result. Uneventful recovery

Intravenous pyelogram, made July 18, 1933, showed on the left side a slightly distorted pelvis, the right side was normal (Fig. 9).

Solitary Cyst of the Kidney: Stone in the Kidney Pelvis

CASE 7. M. S. G. male, aged 61 years, was admitted to the Presbyterian Hospital, October 21, 1928. His chief complaint was hematuria. About 3 months before entering the hospital, patient had noticed that the urine contained blood. He did not experience pain, however, and he thought that the hematuria was due to a strain. A roentgen-ray examination at that time showed the presence of a stone in the left kidney. The urine cleared up in about a week and no blood had been noticed until a week ago.

Pain over the left kidney had begun about 6 weeks before and was described as a dull sore ache localized over the left kidney region. The pain did not radiate, it was not severe, and bore no relation to urination, respiration, or bowel movements.

Physical examination was negative. Urinalysis revealed no albumin, no sugar, some blood. Microscopic examination of the sediment revealed a few red blood cells. Blood examination showed red cells, 4,460,000; white blood cells, 7,400; hemoglobin, 85 per cent. The blood pressure was systolic 104, diastolic 68. The blood Wassermann test revealed a negative reaction. Blood chemistry examination showed urea nitrogen, 23.5; uric acid, 4.4; creatinin, 2.2; non-protein nitrogen, 49.5. Roentgen-ray examination showed the right kidney outline normal. The left kidney outline was normal except for a globular projection at the lower pole which was visible on several films. There was a dense shadow due to a stone in the region of the inferior calyx. A pyelogram which was made of the left side showed it to be normal.

Cystoscopic examination revealed a small median bar. The bladder was otherwise negative. Both ureters were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed

	Leucocytes per cu mm	Cultures	Tubercle bacilli
Bladder	10	Sterile	
Right kidney	20	Sterile	0
Left kidney	20	Sterile	0

In the thalium test the total output of the dye, was 20 per cent in 30 minutes on the right side, 17.5 per cent in 30 minutes on the left side. Operation on May 8, 1929 was done under ethylene anesthesia. The stone was removed through a pyelotomy incision and the cyst (lower pole) was resected.

Result. Uneventful recovery

Blood chemistry May 10, 1934, revealed creatinin 1.2; non-protein nitrogen, 36.3.



Fig. 9. Intravenous pyelogram after removal of cyst, showing a slightly distorted pelvis. Case 6.

Traumatic Cyst of Lower Pole of the Right Kidney

CASE 8. L. C. male, aged 54 years, was admitted to the Presbyterian Hospital June 7, 1930. Five months ago, while at work, the patient fell from a height of 6 feet and struck his right side against a roll of paper. He was able to walk, was taken home, and then to a hospital, where he remained for 14 days. He has been unable to work since the injury. Following the fall, blood in the urine was passed and he had pain of a severe nature in the right upper quadrant which was aggravated by movement. The pain was still present, but not so severe as it was immediately after the injury.

Physical examination showed a marked right costovertebral tenderness and slight rigidity of the right rectus muscle. Urinalysis revealed no sugar, no albumin, blood ++. Microscopic examination of the sediment showed many red blood cells and no casts.

Examination of blood showed red cells, 5,300,000; white cells, 8,750; hemoglobin, 82 per cent. Blood chemistry showed urea nitrogen, 30; uric acid, 4.6; creatinin, 1.3; non-protein nitrogen, 45.5. The Wassermann and Kahn tests were negative. The roentgen-ray examination showed no evidence of stone in the urinary tract. Intravenous pyelograms were made and that of the right side showed a filling defect compatible with tumor. The left pyelogram was normal. Cystoscopic examination revealed the bladder and ureteral orifices, normal. Examination showed that the urine from the right and left kidneys and from the bladder was free of pus and sterile upon culture. The findings in the intravenous pyelogram were verified by a retrograde pyelogram.

Pre-operative diagnosis. Because of the presence of a filling defect on the right side, as shown both with an intravenous and a retrograde pyelogram, a diagnosis of tumor—probably hypernephroma—was made and operation was advised.

Operation was done June 18, 1930, and ethylene anesthesia was used. The usual oblique kidney incision was used. Isolation of the kidney was extremely difficult on account of dense adhesions. A cyst the size of a large orange

was found springing from the lower pole of the kidney. The cyst together with a small amount of kidney tissue was resected.

Result: uneventful recovery.

Subsequent course: A right pyelogram was made on April 2, 1931, and this showed a rather small but otherwise normal kidney pelvis.

Adenoma of the Kidney

CASE 9 Miss F. M. aged 24 years. In June 1920, patient noticed an enlargement on the right side of the abdomen but did not consider it of sufficient importance to consult a physician. Three or 4 months later she called the attention of her family physician to the swelling because of its size. No pain or discomfort or any systemic disturbance occurred until within the last few weeks when there were transient, slight aching pains and discomfort on the right side. The mass, according to her statement, progressively increased in size and at no time were large quantities of urine passed.

Physical examination, March 25, 1924, disclosed a large firm tumor mass which occupied almost the entire right half of the abdomen, extending from about 2 inches above the pelvic brim to the costal arch and medially to the midline. The mass was globular in shape, moved with respiration, was not painful upon palpation, and was about 6 inches in diameter. There was present no evidence of fluctuation.

Blood examination revealed red blood cells 4,000,000, leucocytes 6,700, haemoglobin, 95 per cent. The blood pressure was systolic 5, diastolic 75. Urinalysis showed urine cloudy, acid reaction, albumin +, some blood cells, pus + + +, no sugar, no casts, some epithelial cells. Roentgen ray examination showed, in the right kidney region, an area covered by a large soft parts shadow which extended from the twelfth rib to the crest of the ilium and suggested a much enlarged kidney shadow. Cystoscopic examination showed the bladder and ureteral orifices normal. Both ureters were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed:

	Leucocytes per cu. mm.	Urea	Culture	Cast	Red blood cells
Bladder	30		Sterile		+
Right kidney	90	0.5%	Sterile		++ +
Left kidney	70	0.5%	Sterile		

Time	Right Perc cent	Left Perc cent
at incision and 30 minutes	1	12
Total 45 minutes		20

Right pyelogram showed slight clubbing of the calyces. In the lying position, the pelvis was opposite the first lumbar vertebra; in standing position, the pelvis was opposite the fourth lumbar vertebra.

Diagnosis: tumor of the right kidney.

Operation was done March 28, 1924, under ethylene anaesthesia, and consisted in resection of the tumor and nephrectomy.

Result: uneventful convalescence.

Histological examination revealed an adenoma of the kidney.

Carcinoma of the Kidney

CASE 10 J. R., male, aged eight years, was first admitted to the Presbyterian Hospital, September 17, 1932. At this time a diagnosis of acute pyelitis, due to the *Staphylococcus aureus* was made. The patient was treated with pelvic lavage (1 per cent solution of silver nitrate) and was discharged cured on November 3, 1932. He was admitted to the hospital a second time, February 21, 1933, with chills and fever. There was also noted a mass in the left flank, leucocytosis, and some frequency of urination. A diagnosis of an acute perinephritic abscess was made. The abscess was drained on March 2, 1933, and the patient was discharged on April 15, 1933.

He was admitted to the hospital, a third time, May 31, 1933, because of a persistent sinus in the left flank, tenderness on palpation, and a daily rise of temperature (103 degrees). A retrograde pyelogram (Fig. 6) disclosed a streak of the dye in the region of the left superior calyx. The kidney pelvis and calyces were obscured except for this streak which seemed to be curved upward by a mass which involved the lower 1/3 of the kidney. Urinalysis showed nothing abnormal. The leucocytes numbered 24,700.

Operation was done June 5, 1933, and ethylene and ether anaesthesia was used. The lower half of the left kidney was resected. Result: uneventful convalescence.

Patient was again admitted to the hospital August 16, 1933. Since leaving the hospital about 6 weeks before, he has had no pain, but 10 days ago he began running an afternoon temperature of over 100 degrees, and it was for this reason that he again entered the hospital.

Physical examination revealed extreme tenderness and rigidity to deep palpation on the right side of the abdomen. The impression conveyed was that of the presence of a rounded mass deeply situated in the right upper portion of the abdomen. No tenderness was noted in the left half of the abdomen.

An intra-venous pyelogram showed a progressive filling of the right kidney pelvis and calyces—very little at first, but well filled and dilated on the last film. The pyelogram outline on the right extended through the width of three vertebrae. The left showed small amount of media opposite the first lumbar vertebra and in the ureter. The kidney pelvis and calyces were not outlined and they seemed distorted.

Operation was done September 26, 1933, with ethylene and ether anaesthesia. An incision was made over the right kidney and a perinephal abscess was opened and drained. Patient was discharged from the hospital November 3, 1933.

He was admitted a fifth time November 30, 1933. Eight days after leaving the hospital, a daily elevation in temperature recurring up to 101 degrees, but there was no pain. Physical examination was negative except for the right loin wound which had considerable infected granulation tissue with some purulent discharge. No tenderness was noted in the right flank.

Operation was done November 25, 1933, under ethylene anaesthesia. A large amount of granulation tissue was removed with a curette from the site of the old incision in the right kidney. In the upper end of the wound a large deep cavity was curetted.

Because of the persistent rise in temperature it was deemed advisable to do another operation on the right kidney therefore on January 3, 1934, under ethylene anaesthesia, an incision was made over the draining wound and multiple abscesses in the kidney were incised and drained.

Result: Patient made an uneventful recovery and was discharged, March 2, 1934.

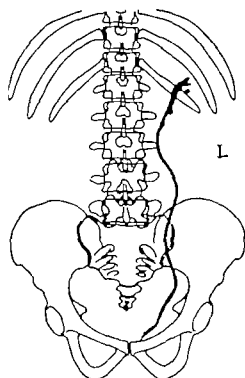


Fig. 10 Retrograde pyelogram showing deformity due to a carbuncle of the lower pole of the kidney. Case 10

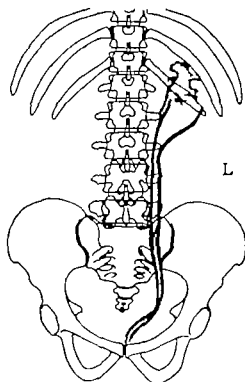


Fig. 11 Showing moderate dilatation of the pelvis of the upper half of the kidney. Case 11

GROUP II—DOUBLE KIDNEYS RESECTION
Complete Reduplication of the Pelvis and Ureter (Left)
Infected Hydronephrosis (Upper Half of Left Kidney)
and Hydro-Ureter

CASE 11. Mrs. A. R. aged 50 years, first entered the Presbyterian Hospital March 2, 1917. Patient gave a history of having had urinary difficulties for 17 years. In 1918 she had had an appendectomy with "no relief" of the symptoms, and within the next 4 years two operations were performed on the bladder for the removal of stones. She was free of symptoms for about 2 years. Upon admission to the hospital, she complained of pain when the bladder was full, pain across the back and left side, frequency of urination, nocturia, urgency and cloudy urine.

Physical examination revealed tenderness over the left upper quadrant and bladder region; otherwise no abnormal symptoms were noted. Urinalysis disclosed no sugar, no albumin, no blood, pus + + + 1 hyaline cast. Examination of blood revealed red cells, 4,800,000; leucocytes, 12,300; haemoglobin, 90 per cent. The blood chemistry examination showed urea nitrogen, 16.86; uric acid, 4.44; creatinin, 1.28; non protein nitrogen, 39.8. The blood pressure was systolic 200, diastolic 120. The Wassermann test gave a negative reaction. The roentgen ray examination was negative for stone. Cystoscopic examination showed a normal bladder with two ureteral orifices on left side; the upper orifices normal. The right ureteral orifice was normal. Both ureters on the left side were catheterized without difficulty or obstruction. The urine at this time showed

	Leucocytes per cent	Culture	Tubercle bacilli
Bladder	5	Staphylococcus epidermidis	
Upper left ureter	536	Staphylococcus epidermidis	
Lower left ureter	20	Sterile	0

In the thalein test (mixed) the total output of dye was 75 per cent in 1 hour. The left pyelogram showed two pelves and two ureters that terminated in the bladder. In the upper pelvis and its corresponding ureter dilatation was marked. The lower pelvis and its ureter was normal (Fig. 11). The right pyelogram was normal. Operation was advised and refused.

On second admission 5 years later patient had the same symptoms and findings except for marked changes in the pyelogram (Fig. 12).

Operation was done March 4, 1933, ethylene anaesthesia being used. A heminephrectomy of the upper half of the double kidney was performed. The ureter to the upper kidney was removed down to the brim of the pelvis, and then nephropexy of the remaining portion of the kidney. At the upper third of the kidney was a line of constriction, above which the kidney showed marked dilatation and was soft and flaccid. There was one blood supply running into the lower half and one into the upper half.

Result: uneventful recovery.

Bilateral Double Kidney and Ureter Hydronephrosis of the Upper Half of the Left Kidney Containing Stones
Stone in the Lower Half of Left Kidney

CASE 12. Dr. J. E. aged 51 years, admitted to the Presbyterian Hospital, October 2, 1933. Symptoms began 18 years ago with an attack of left renal colic, 4 months after which a stone was passed. Nine years later he was seized with an attack of severe renal colic on the left side. Dilatations of the ureter and injections of oil were not successful in securing the passage of the stone, so the ureteral orifice was slit and the stone passed later. Patient was symptom free for 8 years when attacks of renal colic recurred on the right side and were associated with intermittent haematuria and pyuria. About 1 month later (18 months ago) he passed a stone, since which time the urine has continued to show large quantities of pus. Five weeks before entrance to the hospital patient had severe night sweats with chills.

fever of 102 degrees, and hematuria. Ten days ago he experienced a sharp renal colic on the left side which was of short duration and associated with hematuria.

Physical examination was negative. Urinalysis showed no albumin, no sugar, no blood, leucocytes +++.

Examination of blood disclosed red cells, 4,320,000, leucocytes, 6,050, hemoglobin, 95 per cent. Blood chemistry examination revealed creatinin, 1.9 total non-protein nitrogen, 33.3. The blood pressure was systolic 135, diastolic 95.

Cystoscopic examination showed the bladder to be normal. There were two normally placed ureteral openings. Both ureters were catheterized without difficulty or obstruction. The urine obtained at this time showed the following:

	Leucocytes per c.c. urine	Gram reaction	Culture	Tubercle bacilli
Bladder	740	Gram positive cocci	Staphylococcus albus	
Right kidney		No organisms	Sterile	
Left kidney	30	Occasional gram positive cocci	Staphylococcus albus ++	

In the thiamin test the left side showed a total output of 15 per cent of the dye for 1 hour, the right side, 65 per cent for 1 hour. Intravenous pyelograms showed a reduplication of the pelvis and ureter both on the right and left sides. The left upper pelvis showed dilatation and destruction of the calyces; the stone shadows were covered by the media. The lower pelvis showed moderate dilatation (Fig. 5).

Operation was done October 10, 1933, ethylene anesthesia being used. A heminephrectomy was done, resecting the hydronephrotic upper half of the left kidney which contained stones. A pyelotomy of the lower half of the left kidney was done and two stones were removed.

Result: uneventful recovery.

Double Kidney (Right)

CASE 3. Mrs. M. C. aged 41 years was admitted to the Presbyterian Hospital, October 3, 1933. She had had an attack of pain 4 years ago for which she had been given an injection of morphine, and since then has had attacks of pain in the loin occurring at irregular intervals. Associated with this pain, she experienced distress in the bladder and at the external urethral orifice, and had frequency of urination. She also had an attack of hematuria which lasted for one day.

Physical examination was negative except that the lower pole of the right kidney was palpable and tender. Urinalysis showed no sugar, no albumin, no blood, pus + motile bacilli. Examination of blood revealed red cells, 4,000,000, leucocytes, 12,300, hemoglobin, 82 per cent. Blood chemistry showed urea, 50.0, uric acid, 3.0, creatinin, 1.15, non-protein nitrogen, 36. The blood Wassermann test gave a negative reaction. The blood pressure was systolic 120, diastolic 78. The roentgen-ray examination was negative for stone. Cystoscopic examination of the bladder was negative. The right and left ureters were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed:

	Leucocytes per c.c. urine	Culture
Bladder		Colony bacilli
Right kidney		Sterile
Left kidney		Sterile

Thiamin test returned total output of the dye from the right kidney for 30 minutes, 15 per cent from the left kidney 8 per cent.

The right pyelogram showed reduplication of the kidney pelvis and ureter. The pyelograms on the left showed a normal condition.

Gummi pig test showed the bladder and the right and left kidneys negative for tuberculous.

Operation was advised but refused.

Three years later patient returned, complaining of severe attacks of pain. There was essential change in findings. Operation was advised, and on June 3, 1936, under ethylene anesthesia, patient had a resection of the upper half of the double kidney (hydronephrosis).

Result: uneventful convalescence.

Double Kidney and Double Ureter (Left). Hydronephrosis of Upper Half of Kidney and Hydro-Ureter. Ectopic Ureter.

CASE 14. P. D. female, aged 9 years, was admitted to the Children's Memorial Hospital, September 11, 1930. Urinary dribbling had been present since birth. As a baby, child never had had a dry diaper. It was thought that the child would do better when older and trained, but these expectations were never realized. She urinated frequently and the urine could not be held for long periods of time; between urinations, there was constant dribbling. Condition had become more marked during the past 2 years.

Physical examination was negative except that over the middle of the sacrum in midline dorsally there was a defect in the bone that admitted two fingers. External genitalia were negative except that "just below the external urethral orifice was seen a small opening that discharged urine. A ureteral catheter was inserted into the opening and a prompt flow of urine obtained.

Cystoscopic examination was carried out while the catheter was in place. A normal bladder and its normally located ureteral orifices were found. The ureters were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed the following:

	Leucocytes per c.c. urine	Culture
Bladder	295	Bacillus proteus aerobius
Accessory ureter	27	Bacillus pyocyaneus
Left ureter	457	Bacillus proteus aerobius
Right ureter	313	Bacillus pyocyaneus

Urinalysis showed albumin ++ blood 0, sugar 0. Sediment showed pus and red blood cells. Examination of blood showed red cells, 4,000,000, white cells, 0,950, hemoglobin, 80 per cent. Roentgen-ray examination was negative for stone but showed spina bifida occulta. A left pyelogram, with shadowgraph catheters in place, showed that the ectopic ureter drained the upper half of the double kidney. There was a marked hydronephrosis in the upper half of the double kidney; the lower half was normal. The right pyelogram showed a moderate hydronephrosis.

Operation was done October 2, 1930, ether anesthesia being used. A heminephrectomy (left) was done with resection of the accessory ureter which was dilated and tortuous.

Result: uneventful recovery.

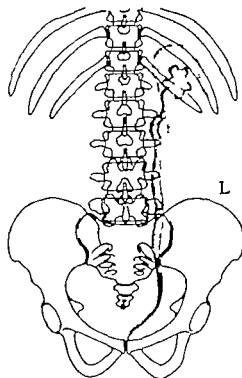


Fig. 12 Showing marked increase in the dilatation of the ureter and pelvis Case 11

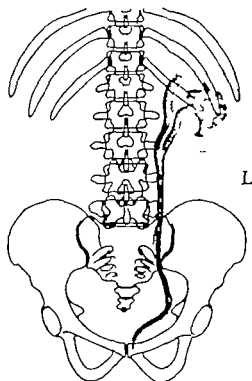


Fig. 13 Dilatation of upper half of double kidney Moderate of lower pelvis Stones covered by skidolane Case 12

Double Kidney, Hydronephrosis Hydro-Ureter of Upper Half Stone in Ureter of Lower Half Retrograde Movement of the Stone

CASE 15 G. H. male, aged 35 years, was admitted to the Presbyterian Hospital December 29, 1931. He had been in good health up to 3 months ago when he first had an attack of severe pain in the right lumbar region which radiated to the right testicle and was associated with gross blood in the urine. The attacks occurred at intervals of 2 to 3 weeks at first, and during the past few weeks almost were daily with 3 to 4 attacks on some days. The pain sometimes occurred only in the testicle. The hematuria was more pronounced during the early attacks than at present.

Physical examination was negative. Urinalysis showed albumin + sugar 0, blood ++ sediment, loaded with pus cells no casts. Cultures showed *Bacillus pyocyaneus*. Examination of blood showed red cells, 4,310,000 leucocytes, 26,400 hemoglobin, 86 per cent. The blood Wassermann and Kahn tests gave negative reactions. The blood pressure was systolic 134, diastolic 60. Roentgen-ray examination showed a stone opposite the third lumbar vertebra on the right side. A subsequent roentgen-ray examination showed that the stone had wandered back up into the kidney and was located in the inferior calyx.

Cystoscopic examination revealed a normal bladder. Two normally situated ureteral orifices were seen. They were catheterized without difficulty or obstruction. Examination of the urine obtained at this time showed

	Leucocytes per cc. min.	Cultures
Bladder	9,600	<i>Bacillus pyocyaneus</i>
Right kidney	80	<i>Bacillus pyocyaneus</i>
Left kidney	40	sterile

Intravenous pyelograms on the right side moderate dilatation of the kidney pelvis and clubbing of the calyces were noted. The stone shadow was opposite the third lum-

bar vertebra. The left side was normal. (The intravenous pyelogram does not show the upper half of the double kidney on the right side. This is due to the fact that the upper half is completely destroyed. There is no secreting tissue present, hence, visualization of the upper half of the double kidney is absent.)

Operation was advised because the ureteral catheterization treatments failed to deliver the stone.

Operation was done March 14, 1932 ethylene and ether anesthesia being used. Two ureters and a double kidney were found. The upper half of the kidney was completely destroyed and the ureter enormously dilated (Fig. 14). Resection of the upper hydronephrotic half was carried out (Fig. 15).

A ureterotomy was done with removal of the stone from the ureter that drained the lower half of the double kidney.

Result: uneventful recovery.

Double Kidney and Double Ureter (Right) Hydronephrosis of Lower Half of Kidney Hydro-Ureter

CASE 16 J. P. female, aged 6 years, was admitted to the Children's Memorial Hospital, November 29, 1933. She had always been in good health up to 3 months ago when she first developed a dull, aching pain in the right kidney region. The pain was practically constant and at times worse at night often causing her to cry and keeping her from sleeping. Occasionally she had fever but there were no urinary symptoms. She has always had enuresis. The pain persisted for 6 weeks before she was taken to a doctor. She had some relief of pain with medication.

Physical examination was negative. Urinalysis showed albumin + blood + sugar 0, pus +, and a few red blood cells. Examination of blood revealed red cells, 4,860,000 leucocytes, 11,300 hemoglobin, 86 per cent. Blood chemistry showed non-protein nitrogen 29. The blood pressure was systolic 120 diastolic 80.



FIG. 14. Resected upper half. Case 3.

Roentgen-ray examination was negative for stone. Right pyelogram (intra-venous) showed a streak of dye running from the last rib to the upper border of the fourth lumbar vertebra. The left pyelogram was normal. Retrograde pyelogram (made elsewhere) showed much looping of the catheter in the right ureter. The ureter dilated and formed a loop opposite the fourth lumbar. Dilatation of the pelvis and calyces was also noted.

This child developed a pharyngitis and bilateral otitis media and a bilateral paracentesis was done. Further work on the kidney was postponed and patient was discharged, January 9, 1934.

On second admission, February 27, 1934, no essential change in condition was noted.

Operation was done March 1, 1934, ether anesthesia being used. A heminephrectomy of the lower half of the double kidney was done. The dilated ureter to the lower kidney was removed about 8 centimeters from the pelvis. A nephropexy of the remaining portion of the kidney was done. There was a line of demarcation between the two portions of the kidney and the lower half was composed of a markedly enlarged hydrocephrotic sac with a shell of renal tissue.

Result: uneventful recovery.

This case is interesting in that the lower half of the kidney showed the pathological condition and

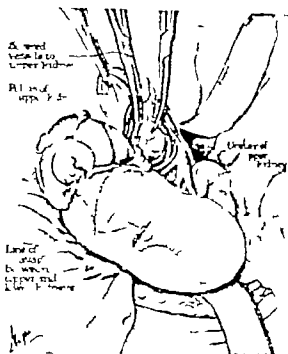


FIG. 15. Note enormous dilatation of upper ureter and pelvis. Case 3.

was resected, which is the exception since it is most frequently the upper and embryonic half that is the seat of disease.

My experience agrees with that of Herbst and Polkey who found that the danger of hemorrhage and fistula is rare in the experimental animal.

The question of hemorrhage was not troublesome in this series of cases, neither at the time of the resection nor subsequently. In the cases of double kidneys it was a relatively simple procedure to isolate the vascular supply to the diseased half and to ligate the vessels before the resection was done. If this procedure is followed the operation is practically bloodless.

In the 10 cases of normally formed kidneys in which resection was done, there was no difficulty in controlling the bleeding with sutures. In none of these cases was the bleeding marked. In 1 case with a very slight oozing a piece of fat was transplanted.

Reference to the possibility of a persistent post-operative urinary fistula has been mentioned by some authors. In this series there were no fistulae. Careful suturing will, in all probability prevent the occurrence of a postoperative fistula. When one of the calyces has been opened great care should be exercised in its closure by careful suture.

The determination of the line of resection is generally quite simple. In the cases of double kidney a line of demarcation between the normal half and the pathological half is readily discernible in most cases, although in a rare case such may be absent or poorly defined.

As a rule in the cases of solitary cyst but little difficulty is experienced in finding a line of cleavage between the cyst and the kidney. Likewise in the one case of benign tumor reported in this paper little difficulty was experienced in finding the line of cleavage and it was easily followed by blunt dissection.

If a stone is present and there is also a cavity no line of cleavage can be demonstrated on the surface of the kidney. In such cases great care was taken to remove these cavities completely.

In the presence of stone two kinds of resections were carried out. In 4 cases the line of incision cut across the kidney from its outer to its inner border. In one case, in which the stone corresponded

more or less to a dumb-bell in its configuration a wedge shaped resection of the kidney was done (Fig 4).

BIBLIOGRAPHY

- 1 BARDENHEUER, B. Verhandl. deutsch. Gesellsch. f. Chir. 1891, 20, 111.
- 2 BLOCH, O. Brit. M. J., 1896, 2, 1100.
- 3 CIERNY. Quoted by Herzfel.
- 4 EISENDRATH, PRIFER, and COLVER. J. Urol. 1925, 13, 525.
- 5 HERZEL, E. Beitr. z. klin. Chir. 1890, 6, 485.
- 6 HERBST, R. H. and POLKEY, H. J. Surg. Gynec. & Obst. 1931, 51, 215.
- 7 JUDD, E. S. Ann. Surg. 1925, 82, 458.
- 8 KENTLEY, C. B. Brit. M. J., 1890, 2, 147.
- 9 KUMMELL, H. Deutsche Gesellsch. f. Chir. 1893, 22, 146. Centralbl. f. Chir. 1890, 17, 339.
- 10 MOYNGHAM, G. A. Brit. M. J. 1902, 1, 263.
- 11 PETERS, W. Beitr. z. klin. Chir. 1923, 129, 716.
- 12 RATHBUN. Am. J. Surg. 1931, 13, 565.
- 13 SPITZGELBERG, O. Arch. f. Gynæk., 1870, 1, 140.
- 14 WAITZ, H. Deutsche med. Wchnschr. 1891, 17, 495.
- 15 WELLS, S. Brit. M. J. 1884, 1, 758.
- 16 YOUNG, H. H. Surg. Gynec. & Obst. 1924, 38, 107.

THROMBOPHLEBITIS AND EMBOLISM

WITH SPECIAL REFERENCE TO THE DANGER OF PULMONARY EMBOLISM IN THE INJECTION
TREATMENT OF VARICOSE VEINS

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PULMONARY embolism is generally feared in any case of thrombophlebitis of the lower extremities. Postoperative, infectious, traumatic or spontaneous thrombophlebitis are too frequently associated with embolism. However, Speed in 1927 reported 30 deaths from pulmonary embolism within a 10 year period at the Presbyterian Hospital of Chicago with the location of the thrombus in the lower extremities in only 7 cases. The location of the thrombus is an important factor. Thrombophlebitis in the arm veins alone very seldom leads to this complication. Similarly, a clinically indistinguishable type of thrombophlebitis produced by the injection of chemical irritants for the obliteration of varicose veins is relatively safe from pulmonary embolism. McPheeters (21, 22) in 1928 after a thorough search of the literature, found only 4 cases of fatal pulmonary embolism in a total of 53,000 cases of varicose veins treated by injection.

In 1931 von Karsten Kettel collected reports of 60,000 treated cases of varicose veins with 10 deaths due to pulmonary embolism. Only 1 of these 10 deaths can be attributed to the present recognized technique. Silverman, in 1931 found reports of 17 deaths besides 1 of his own and 3 non-fatal cases of pulmonary embolism. The almost universal use of chemical irritants for obliteration of varicose veins in itself speaks for the safety of this type of thrombosis.

Doubtless other cases of fatal and non-fatal embolism have occurred and have not been reported. Not only the imminent danger of emboli in other types of thrombophlebitis but the knowledge of unreported cases in obliterating varicose veins has contributed to the hesitancy of the general surgeons in particular in accepting the safety of any case of thrombophlebitis. Since the following case of non fatal embolism occurred, careful routine physical examinations and selection of cases, strict postinjection instructions, and co-operation of the patient have prevented recurrence of the complication. This case is reported and discussed to point out the dangers which are not usually recognized by the less experienced in this type of procedure.

REPORT OF CASE

Mrs. P. aged 40 years, reported to the surgical dispensary April 7, 1930, suffering with large tortuous varicosities of the left thigh and leg. The internal saphenous vein was markedly enlarged and anastomosed. Trendelenburg and Perthes signs were positive. She had had the vein condition for years. She complained of left lower abdominal distress and had lost 15 pounds in weight during the previous month. She attributed this to a recent court experience and worry about her divorce. However she was referred to the department of general medicine for a complete check-up. On April 17 she reported back to the surgical dispensary that she had been examined and nothing was found to interfere with the injection treatment. She was then given one injection of 50 per cent dextrose solution in the left internal saphenous vein at the level of the lower thigh. Two days later the expected moderate inflammatory reaction developed and extended to the femoral ovals and calf. Consequently she went to bed. Being without a home and having no one to take care of her she called the social service department and was promptly admitted to the hospital on April 19, 1930.

At the hospital her leg was elevated and hot packs were applied. On the second day her temperature was 100.4 degrees, pulse 84, and respiration 20. On April 22, her general condition was very good and the pain and swelling along the course of the left internal saphenous vein were markedly improved. On April 24 without any change in her general condition, her temperature went up to 101 degrees. She complained of considerable tenderness and distress in the left lower abdomen. No chest pain or dyspnea were present. April 27 (10 days after injection) she was given magnesium sulphate for constipation. She experienced a sharp chest pain which lasted a few minutes. No cough or dyspnea was present and physical examination of the chest was negative. Her temperature rose to 103.4 degrees. Additional history then proved that she had had a left lower abdominal abscess 18 years ago which required 10 months hospitalization. Further inquiry revealed that she did not have the required general examination. Because of her recent divorce, she was anxious to have her sins treated without delay.

On April 28, a diagnosis of recurrent extraperitoneal abscess was made. On advice of a gynecologist on May 3 a posterior colpotomy was performed. After thorough exploration only a small amount of clear serous fluid was found. Otherwise conditions were normal. The serous discharge was thought to be a transudate from an abdominal abscess. Colpotomy drainage continued to be practically nil but the temperature fluctuated between 100 and 101.4 degrees. The left lower abdominal mass rapidly enlarged until it reached the umbilicus. On May 9 the abscess was opened through a left abdominal incision. A large amount of color odored material was evacuated. There was no question about the abdominal location of the abscess as it was completely walled off by omentum and coils of gut.

The day following operation for draining the abscess, a right internal saphenous thrombophlebitis developed 37 to

days later the woman experienced sharp pains posteriorly on both sides of the chest. The next day (May 13, 1930) consolidation of the left lower chest was detected. Repeated aspirations of the left chest revealed a thin yellow serous fluid. No organisms were present on culture. Her temperature came down to normal but the abdominal discharge continued for months (discharged to convalescence home December 12, 1930).

After being in fairly good health for more than a year she suddenly developed a panophthalmitis. This seemed to be of embolic origin. The eyeball was removed.

This is an unusually complicated case of pulmonary embolism to be definitely attributed to the injection of dextrose in varicose veins alone. In the first place, the patient had lost 12 pounds in weight and complained of severe left abdominal distress for more than a month prior to her first visit. Undoubtedly the confinement of the patient to bed, the debility of the patient due to the rapidly developed large abdominal abscess with a very high septic temperature all contributed to the pulmonary embolism. Even if the patient had not received an injection for her varicose veins postoperative thrombophlebitis and embolism could have developed. In fact, definite evidence of embolism was not detected until after thrombophlebitis developed in the right (opposite) leg subsequent to the second operation for draining the abdominal abscess.

Several factors may contribute to pulmonary embolism consequently every means should be used to avoid their occurrence when thrombophlebitis is likely to develop. The following conditions further the development of pulmonary emboli:

1. Limited damage or destruction of the endothelial lining of a vein leading to thrombus formation provides insufficient attachment of the clot to the vein wall.
2. Inactivity of the patient results in the formation of large coagulation stagnation thrombi instead of the limited solid mixed deposition thrombi.
3. Coagulating solutions for intravenous injections produce unattached coagulation clots.
4. Suppurative infection, either caused by direct contamination from surrounding tissues or hematogenous in origin is followed by disintegration and loosening of the clot.
5. Direct trauma or massage of the thrombotic area may loosen and detach a portion of the thrombus.

The extent of intimal damage leading to thrombus formation is of primary importance when the danger of emboli is considered (Fig. 1). Pathologists are frequently unable to locate the origin of a fatal embolism in the saphenous or femoral

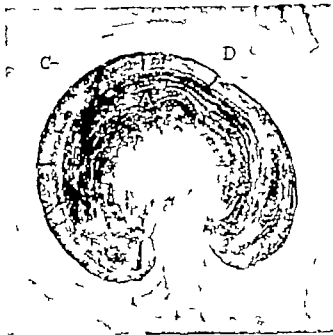


Fig. 1. Photomicrograph of laminated postoperative thrombus of the internal saphenous vein. This specimen was obtained at autopsy following death from postoperative pulmonary embolism. The thrombus, *A*, is attached only at the site of origin on a valve *B*. The rest of the clot is completely free from any other intimal attachment, *C*. Practically the entire intima is intact, *D*.

vein. However Aschoff and Kaufmann believe that intimal damage is always present. This damage may be due to trauma at the operative field such as crushing with forceps or ligature or indirect injury by means of retractors to infection either hematogenous through the vasa vasorum or through direct extension from surrounding tissues or to chemical and toxic agents. With the injection treatment of varicose veins skilfully administered a non-coagulating chemical irritant is held undiluted in contact with the intima for sufficient time to insure extensive annular destruction of the endothelium (32, 33). The more extensively the intima is destroyed the more firmly attached will be the thrombus to the vessel wall.

At operation for the removal of biopsy specimens of injected varicose veins it is apparent that the thrombus is firmly adherent. Forceps and scissors are required to separate the thrombus from the vein or the vein from the surrounding tissues (Fig. 2). I am convinced that the attachment of a deposition thrombus at the site of extensive intima damage prevents its detachment with resulting embolism.

This is contrary to McPheeters' investigation (23) which showed that the reverse flow of blood in varicose veins prevents pulmonary embolism. By means of lipiodol and skiodan injections roent



Fig. 2 Photomicrograph of biopsy specimen of thrombosed internal saphenous vein following injection of chemical irritant for the obliteration of varicose veins. (The entire circumference of the intima has been destroyed and no line of demarcation exists between the remaining portion of the vein wall *B* obliterating thrombus, *A* and perivenous tissue *C*.)

genograms revealed the flow of blood away from the heart. Blood pressure readings and posture tests (Trendelenburg and Perthes) substantiated these findings. With the patient in the upright position the reverse flow of blood in varicose veins would hold true but in the prone position the flow is toward the heart.

Inactivity of the patient subsequent to intimal damage is followed by the formation of a red stagnation clot. Debilitated, bedridden patients are most likely to incur this danger especially in the postoperative period. Red stagnation thrombi are somewhat similar to blood clots *in vitro* loosely held together rapidly disintegrating, and contracting away from the wall of the vein. This type of thrombus may occur as the primary clot, i.e. postoperative, or as a secondary coagulation thrombus superimposed on a pre-existing mixed deposition thrombus. These secondary stagnation clots are particularly dangerous in patients confined to bed following the injection treatment of varicose veins.

With the circulation normally maintained by the continued routine activity of the patient, the gradual formation of a deposition thrombus takes place. This is a firm, mixed, and laminated platelet thrombus with a minimum amount of erythrocytes. To each end, proximally and distally a red

clot extends to the next branch (Fig. 3). Under ordinary circulatory conditions, the deposition thrombus at the site of the damaged intima and the proximal and distal red clots are firmly united in a solid mass. However when thromboses once starts, the rapidity of the circulating blood determines the size and type of the resulting thrombus. With markedly impaired circulation the additional red thrombi may not stop at the adjacent branch but may extend into the larger and smaller veins. When marked myocardial degeneration exists, unusually large thrombi may develop from the site of very limited endothelial damage.

The greatest danger of emboli exists in the presence of coagulation thrombophlebitis (18). These thrombi may occur either as primary coagulation clots or secondary to a mixed clot as heretofore described. In almost all of the reported and unreported deaths from pulmonary embolism in the injection treatment of varicose veins, confinement of the patient to bed preceded the complication. Perivenous tissue necrosis from the injections, bilateral multiple injections at one sitting or severe inflammatory reaction from improper selection of cases, or careless surgical asepsis interfere with the normal activity of the patient. Olson reported one death after injection from pulmonary embolism in a patient 3 days after hospitalization. A patient of von Eiselsberg died after 10 days of hospitalization for excision of an area of necrosis and ligation of the saphenous vein. Faure's patient was confined to bed for 16 days after injection she developed a non-fatal pulmonary embolism the day following her discharge from the hospital. Nohl (12) reported 1 death 3 days after hemorrhoidectomy in a patient who had received injections 6 weeks previously. Both Isaac and de Takats (7) reported cases in which patients who had received injection treatment developed pulmonary embolism after confinement to bed for emergency appendectomy. McPheters and Rice had 2 deaths from pulmonary embolism following hospitalization for excision of postinjection necrosis. It is most important that the routine daily activities of the patient should be encouraged during the course of treatments.

The importance of ambulatory treatment of thrombophlebitis when possible cannot be over emphasized. Homans, of the Massachusetts General Hospital, reported 3 deaths from pulmonary embolism in 162 ligation thrombophlebitis cases confined to bed. De Takats (9) advises ambulatory ligations of the internal saphenous vein and has had no deaths from this cause in more than 200 ligations. Viggiano questions the

advisability of confining patients to bed following any varicose vein operation. Instead of the usual 2 to 3 weeks in bed he believes it might be best to permit the patient to be up and about the same day. Meyer Wildisen advises that intravenous or intramuscular injections in general be given in the arms. There is always more movement in the arms than in the legs in bedridden patients. He reports no emboli since this postoperative regimen has been followed. At the Presbyterian Hospital of Chicago 3 bedridden patients developed thrombophlebitis of the arms. No embolic complications occurred.

In my personal series of more than 14,000 injections (882 patients) each one of which was expected to produce an area of thrombophlebitis, only 1 injection was followed by pulmonary emboli and this patient had been confined to bed for 10 days before the complication occurred. Linser, McPheeters (22) and de Takats (8) all advise ambulatory treatment when possible even in the presence of a severe postinjection reaction. However, McPheeters' recommendation that an entire limb be injected at one sitting is entirely too severe to expect the full ambulatory co-operation of the patient. In every case of spontaneous, traumatic, non-suppurative infectious thrombophlebitis in which the patient is already ambulatory, I insist upon continued activity. Even in the presence of a low grade temperature I no longer confine him to bed. In more than 50 such cases I have had no instances of pulmonary embolism or serious complications.

Suppurative infection is extremely serious in the presence of thrombophlebitis. The pyogenic infection might be the cause of the original thrombosis as may occur from a surrounding abscess, from direct inoculation by the injection, or from a septicæmic or pyæmic hematogenous dissemination. Disintegration of the accumulated leucocytes produces proteolytic action of the thrombus itself as well as of the attachment of the thrombus to the wall of the vein. Pyæmia and embolism are very commonly observed. This must not be confused with the non-suppurative inflammatory reaction which is often seen. In a series of these cases Brown was unable to get culture growths from either the inflamed vessel or the contained thrombus.

Coagulating chemicals should never be used in intravenous injections. Early in the injection treatment of varicose veins, Pregl's isotonic iodine solution was advocated. Numerous deaths followed the clotting effect of the solution on the blood. With limited attachment of the thrombus on the wall of the vein the extensive coagulation

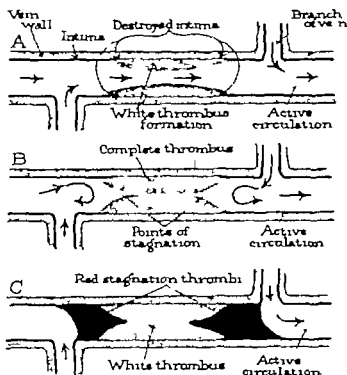


Fig. 3. Schematic illustrations showing the formation of an obliterating thrombus in a blood vessel. With an active circulation the occluding thrombus extends from the site of origin on the damaged intima to the next proximal and distal branches. With an inactive stagnant circulation the thrombus may extend for considerable distance to the larger proximal branches. These latter secondary coagulation thrombi are unattached to the wall of the vein (Fig. 1) and are easily dislodged and broken off to form emboli.

thrombus is easily dislodged. Three of the 10 deaths from pulmonary emboli reported by von Karsten Kettel were due to the use of this solution. Its use has been completely discarded (14).

Direct trauma and massage to a thrombotic area are dangerous. The superficial inflammatory reaction which so frequently accompanies thrombophlebitis is occasionally massaged with a liniment or ointment. Even the more intelligent lay people are often inclined to do this unless definitely informed to the contrary. Direct trauma as in athletics may be the cause of breaking loose of a fragment of the thrombus. Kilbourne reported 1 death following massage of the limb after injection.

PREVENTION OF PULMONARY EMBOLISM AFTER INJECTION

Basically thrombophlebitis is always a potential source of embolism. The ruthlessness with which emboli strike and the helplessness of treatment compels the use of preventive measures to avoid thrombosis which cause the emboli. Naturally to produce a thrombophlebitis deliberately could be severely criticized. At the Presbyterian Hospital of Chicago 70 patients were treated dur-

INCIDENCE OF THROMBOPHLEBITIS OF THE LOWER EXTREMITIES AND PULMONARY EMBOLISM AT THE PRESBYTERIAN HOSPITAL OF CHICAGO

Cases	Cases of thrombophlebitis	Pulmonary embolism			
		Frequency		Mortality	
		No.	Percentage	No.	Percentage
Admitted with thrombophlebitis	9		100	2†	22
Postoperative thrombophlebitis	16	8	50		00
Postpartum thrombophlebitis					
Total number of cases	25	8	32	2	25

*Trauma to and spontaneous

thrombophlebitis

†Death occurred on day following resection of the thrombotic internal saphenous vein

ing the past 10 years for thrombophlebitis of the lower extremities. Twelve or 17.1 per cent developed pulmonary emboli which resulted in 5 deaths—a mortality of 7.1 per cent in patients with thrombophlebitis.

In a series of thirty deaths from postoperative embolism at the Presbyterian Hospital of Chicago, Speed in 1927 found that the thrombosis occurred only 6 times in the leg and once in the thigh. This indicates that thrombosis in the extremities is less apt to cause embolic death than in other locations. However, Cleland and Barlow report that 2.5 per cent of all autopsies showed pulmonary embolism, and in every instance the original clots were found in the leg veins.

Hunt at the City Hospital of Worcester, Massachusetts, reports 94 surgical, traumatic, and obstetrical cases of thrombophlebitis. Almost 25 per cent of these cases with thrombotic complications died of pulmonary embolism. Tempely from the Kuettnier clinic compiled the frequency of thrombosis and embolism according to the seriousness of the surgical condition and the debility of the patient following operation. In carcinoma of the stomach and rectum, pulmonary emboli occurred in 1 to 3 to 1 to 2 cases of thrombosis, respectively. Simple herniotomy was followed by thrombophlebitis in only 0.8 per cent of the cases, but 25 per cent of these developed fatal pulmonary embolism. In appendectomy one embolism occurred to each 7 of thrombophlebitis. Brown, at the Mayo Clinic, recognized pulmonary infarction in 33 per cent of 87 cases of thrombophlebitis although no deaths from pulmonary embolism occurred.

Frequent suggestions appear in the literature attempting to reduce the incidence of thrombophlebitis with its accompanying danger of embolism. In a statistical review of pulmonary em-

bolism Henderson emphasized the importance of age, weight, general condition of the patient, efficiency of circulation, bodily inactivity, and infection. Snell found that obesity or weight did not definitely contribute to embolism. Walters, in a symposium on fatal pulmonary embolism before the 1927 Clinical Congress of the American College of Surgeons, expressed the opinion that lowering of the blood pressure, depression of metabolism, and possibly slowing of the circulation as a result of prolonged rest in bed, play an important part in either the predisposition to, or the causation of, postoperative thrombosis and emboli. Following a regimen to overcome these factors including thyroid medication he reports a 75 per cent reduction in fatal pulmonary embolism. Bancroft and Brown believe that changes in the blood itself are probably the most important. On the other hand Allen, after extensive investigation, states that the "non-specific physiological changes in the blood in all probability play only a minor part in contributing to thrombophlebitis and embolism. Miller believes that the outstanding single factor concerned with thrombophlebitis and embolism is stasis of the blood in the pelvis." In spite of the investigations and reports with suggestions to reduce the incidence of thrombosis and embolism, many European clinics have found an alarming increase.

In discussing the prevention of postoperative pulmonary embolism David advises that "patients should not be allowed to remain in one position during the first few days when so little inclination exists to move. The position of the legs should be frequently changed and in almost all abdominal surgery the patient should be turned on the side for certain periods during the day. It is interesting that in the herein reported 39 cases of postoperative thrombophlebitis of the ex-

tremities at the Presbyterian Hospital of Chicago none occurred on his service. This regimen is particularly valuable in those patients who after injection require confinement to bed for emergency conditions such as appendicitis, etc.

With each injection of a chemical irritant a deposition mixed thrombus adherent to the damaged vein wall is expected to obliterate the varicose vein permanently. In more than 14,000 injections (882 patients) which I have personally given, an equivalent number of potential sources of emboli is provided. However with only 1 injection did this complication occur. In this series the patients' ages ranged from 16 years to 89 years with the large majority between 30 and 45 years. At least 8 per cent were obese, 1 per cent cardiac and $\frac{1}{2}$ per cent controlled diabetics. Another 10 per cent were unusually thin. In 10 per cent of the cases there had been a previous thrombophlebitis. The size of the veins treated varied from the small superficial telangiectatic type to the huge tortuous type covering both leg and thigh. No patient has been refused injection treatment because of age, weight, cardiac compensation, controlled diabetes, or a thrombophlebitis not less than 2 to 5 years previous. However, in less than 4 per cent of the patients injections were postponed because of recent thrombophlebitis, untreated cardiac condition, diabetes, hyperthyroid or other systemic infirmities, serious peripheral arterial disease with danger of impending gangrene, local infection, ulcerations, eczema, indurations or swelling of the legs and feet or systemic infections, such as grippe, colds, bronchitis, etc. I have had called to my attention 3 unreported cases of sudden death following the injection treatment. All had been confined to bed but details are lacking as to the terminal clinical picture.

CONCLUSIONS

Pulmonary embolism may occur in any case of thrombophlebitis. In more than 14,000 injections (882 patients) for the obliteration of varicose veins each one of which was given to produce an area of thrombophlebitis, only 1 was followed by pulmonary embolism and that non-fatal. This did not occur until after 10 days' confinement to bed.

Pulmonary embolism occurs most frequently in bedridden, debilitated and cardiac patients. With limited attachment of the thrombus to the vessel wall the deficient circulation of blood aids extensive secondary red stagnation thrombus formation. These are easily dislodged and carried away in the circulation.

Although thrombophlebitis produced by injection of chemical irritants, trauma, or infection is

indistinguishable clinically nevertheless pathologically there may be a marked difference. The possibility of detachment of a thrombus and embolism formation depends upon the pathological type of thrombus present.

Coagulation or secondary stagnation thrombi because of lack of intimal attachment are particularly prone to cause embolism. The intravenous injection of a coagulating chemical irritant or a very limited break in the intima may be the source of extensive coagulation thrombosis.

Deposition or pulsion (Aschoff) thrombi are expected to obliterate varicose veins following the injection of non-coagulating chemical irritants. Extensive intimal damage provides adequate attachment for the thrombus. There is very little danger of detachment or extensive secondary thrombus formation unless the patient is subsequently bedridden.

Suppurative infection or direct injury to a thrombotic area may contribute to the disintegration or dislodgement of any type of thrombus.

Nevertheless thrombophlebitis of the extremities irrespective of the cause, is less likely to be followed by pulmonary embolism than thrombosis in other locations.

In the injection treatment of varicose veins proper selection of cases for injection, skilled technique and complete cooperation of the patient after injection in continuing routine daily activities will lessen the frequency of pulmonary embolism.

BIBLIOGRAPHY

1. ALLEN, EDGAR V. Changes in the blood following operation. *Arch Surg* 1927 15:254-263.
2. ASCHOFF, L. *Pathological Anatomy* Vol 1. Jena: Gustav Fischer 1928.
3. BANCROFT, FREDERICK W. and BROWN, STANLEY. Postoperative thrombosis, thrombophlebitis and embolism. *Surg. Gynec. & Obst.* 1932 64:808-806.
4. BROWN, GEORGE E. Postoperative phlebitis. A clinical study. *Arch Surg* 1927 15:245-253.
5. CLEVELAND, J. B. and BARLOW, D. L. Deaths from pulmonary embolism. *M. J. Australia*, 1932 1:173-176.
6. DAVID, VERNON. *Surg. Gynec. & Obst.* 1930, 50:158-159.
7. DE TAKATS, GEZA. Causes of failure in injection treatment of varicose veins. *J. Am. M. Assn.* 1932 96:1111-1114.
8. Idem. Residing infection in varicose veins. Its diagnosis and treatment. *Am. J. M. Sc.* 1932 124:37-66.
9. DE TAKATS, GEZA, and QUILLIN, LAWRENCE. Ligation of saphenous vein. A report of 300 ambulatory operations. *Arch Surg* 1933, 26:72-88.
10. FAURE, MONDE MED. 1926 36:56.
11. HENDERSON, E. F. Fatal pulmonary embolism. A statistical review. *Arch Surg*, 1927 15:231-236.
12. HINCHER, MAXIMILIAN. Is obliterating varicose veins without preliminary high saphenous ligation permissible? *Wien. Klin. Wochenschr.* 1926 39:1310-1311.

- 13 HOMANS, JOHN. Nelson System of Surgery Vol 3, p 748 New York Thomas Nelson & Sons, 1937
- 14 HORN, O. and FOGEL, J. Risk of embolism in the injection treatment of varices. Clinical and experimental study. Mitt a d Grenzgeb d Med u Chir 1931 42 400
- 15 HUNT, E. L. Postoperative thrombosis and embolism. New England J Med 1933, 308 730-739
- 16 ISAAK, LEONIG. The danger of emboli in artificial varicose vein sclerosis. Muenchen med Wchnschr 1932, 79 1060
- 17 KAUFMAN, LEONARD. Special Pathological Anatomy. Walter de Gruyter and Co 1931
- 18 KETTEL, VON KASTEN. Fatalities following injection treatment of varices—etiology and pathogenesis of emboli. Zentralbl f Chir 193 38 1498-1510
- 19 KILBOURNE, NORMAN. Treatment of varicose veins of legs, consideration of safety. J Am M Ass 1930, 93 1370-1374
- 20 LINDER, PAUL. Is the non-operative obliteration of varicose veins dangerous? Zentralbl f Gynaek 1931 55 1442-1444
- 21 MCPHERTER, H. O. Varicose Veins. Philadelphia F. A. Davis Company, 1930
- 22 MCPHERTER, H. O. and RICE, C. O. Varicose veins complications, direct and associated, following injection. J Am M Ass 1928, 91 1090-1094
- 23 MCPHERTER, H. O. MERRITT, C. E. and LUNDGARD, ROY A. Mechanics of the reverse flow of blood in varicose veins as proved by blood pressure readings. Surg. Gynec & Obst, 1932, 55 308-302
- 24 MEYER WILDIEN, ROBERT. Damage from injections and frequency of emboli. Zentralbl f Chir 193 39 2263-2266
- 25 MILLER, EDWIN M. Surg. Gynec & Obst 1930, 50 157-158
- 26 OLSON, O. A. Fatality following varicose vein injection. J Am M Ass, 1937 89 602
- 27 RUMENOWSKY, E. Quoted by Moszkowicz, L. See note 35
- 28 SILVERMAN, ISIDORE. Incidence of embolism in treatment of varicose veins with sclerosing solutions. Report of case. J Am M Ass 1931 97 177-178
- 29 SKILL, ALBERT M. Relation of obesity to fatal postoperative pulmonary embolism. Arch Surg 1927 15 237-244
- 30 SPIED, KELLOGG. Postoperative pulmonary embolism. Ann Surg 1927 85 44-53
- 31 TEMPEST, ARTHUR. Postoperative pulmonary embolism. Brit J Clin Chir 1928, 144 170-177
- 32 TREES, FRANK A. Principles and technique of injection treatment of varicose veins. Surg Clin N America, 1931 11 157-171
- 33 Idem. Basis for recurrence of varices in the various forms of thrombophlebitis. Ann Surg 1933, 93 82
- 34 VOTARO, JULIUS. Danger of thrombosis and embolism in varicose vein operation. Zentralbl f Chir 1932, 59 2681-2684
- 35 VON ENSELEBERG, ARTHUR. Quoted by Moszkowicz, L. Treatment of varicose veins with hypertonic sugar solutions. Wien med Wchnschr 1927 77 461
- 36 WALTERS, WALTERMAN. A method of reducing the incidence of fatal postoperative pulmonary embolism. Surg. Gynec & Obst 1930, 50 54 157

EVOLUTION AND PRESENT TECHNIQUE OF GASTROJEJUNOSTOMY

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GASTROJEJUNOSTOMY as it is performed today represents the crystallization of 53 years of scientific observation and development. While part of the knowledge of this branch of gastric surgery is the result of laboratory experimentation, probably more has been acquired by the method of trial and error in clinical surgery. The sustained interest in this operation is perhaps occasioned by the indubitable fact that for those conditions in which it is indicated, it is one of the most satisfactory therapeutic procedures known to surgery.

The first 20 years of experience with this operation occurred contemporaneously with the development of abdominal surgery and the establishment of the principles of physiology of the gastro-intestinal tract. These 20 years may be described as the period of groping in the dark toward a light which probably even now has not attained its full brilliance. The success of the first gastrojejunostomy suggested that it was an operative procedure of value. Difficulties were encountered early and these were not overcome easily because of the incomplete knowledge of the anatomy and physiology of the gastro-intestinal tract. Some 50 different methods, techniques and procedures for the operation have been devised. Many of them have been discarded as valueless yet each has made its contribution to the present day method of gastro-intestinal anastomosis. Good results often followed operations which were not technically sound. The words of Kocher (26) in reply to a criticism of his method are worth repeating.

It is well that Nature is not so ungracious as the surgeon. She allows, just as God allows the sun to shine on good and evil, methods which theoretically are good and bad to be successful.

The first gastrojejunostomy was performed by Anton Woelfler (85) in Billroth's clinic in Vienna on September 28, 1881. Events which led to the performance of this particular operation are of interest. As early as 1874 Gussenbauer and von Winwarther had performed pylorotomy on dogs successfully. Pean did the first partial gastrectomy in 1879 but his patient died. The first successful partial gastrectomy in man was done by Billroth (3) on February 4, 1881. Woelfler, his assistant, reported 3 additional partial gastric resections later in the same year. With the intention of performing a partial gastric resection on an

other case Woelfler opened the abdomen of the patient and found a mass which had infiltrated the surrounding tissues. The infiltration was of such character that gastric resection was impossible. It has been related that he was ready to close the abdomen when Nicoladoni who was present in the clinic at the time, suggested that an anastomosis be made between the stomach and the small intestine. There is no record that even suggests the source of Nicoladoni's inspiration unless it be his acquaintance with the successful performance of entero-anastomosis by Gely and Maisonneuve (36) which was reported in 1864. Woelfler proceeded with the proposal of his colleague and recorded his operative technique as follows:

The stomach was opened one finger's breadth above the attachment of the gastrosplenic ligament at the greater curvature by means of a longitudinal incision 5 centimeters long. A loop of the small intestine was pulled up and split in the same length at the surface situated opposite to the mesentery. The edges of the lumen of the small intestine were then inserted into the edges of the gastric lumen in such a manner that the posterior margins of the intestinal lumen were united with the posterior margins of the lumen of the stomach by internal circular sutures with silk threads. At the anterior margins of the gastric lumen and of the intestinal lumen the margins of the mucous membrane were at first attached to each other, then the serosa and muscularis surfaces by means of a modified Lambert's suture. After careful disinfection of the entire field of operation with carbolic acid, the abdominal layers were again closed, and the united wound was covered with an iodoform dressing. During the entire operation the stomach and the intestinal loop which had to be inserted were placed upon disinfected sponges. In order that during the operation no intestinal contents should escape, the intestine was closed off in the efferent and afferent portion with a thick silk thread which passed through the mesentery. This method of temporary closure appears to be the most simple and the most appropriate. The operation was carried out under strictly antiseptic precautions but without the use of a spray. No drainage of the peritoneal cavity was done. The course following the operation was satisfactory in every way. The patient remained completely free from fever and felt progressively better since the day of operation. The annoying vomiting ceased. From day to day the patient could take progressively larger quantities of food. At first only a liquid diet was given. From the eighth day on solid food was given without undue results. The wound of the abdomen healed under a dressing by first intention. Four weeks after the operation, the patient has daily evacuations of stools, which are firm and brown color. By means of the gastroenterostomy the author has excluded the carabomatous pylorus from the channel of nutrition for which he has found a new way. The food reaching the stomach travels a new way and the inflow of bile and of the pancreatic juice through the afferent portion of the intestinal loop is not prevented. The many physiological questions which are concerned can-

not at present be answered. This much is assured, namely, that all the theoretical considerations which could be cited against the operation are removed by the successful result of the operation.

The final comment of this report is significant.

The success of the operation is established regardless of any theoretical considerations which may be cited against it.

Practically it is of little importance, even today, whether the good results of the operation are due to the neutralizing action of the intestinal juices on the gastric contents, or to simple drainage facilitated by the new outlet of the stomach.

The fortunate outcome of the first case served as a stimulus to its further use. On October 2 1881 4 days after Woelfler's first case, Billroth performed the second gastrotomy (4). His patient also had an irreducible carcinoma of the pylorus which had extended into the pancreas. The operation was terminated within an hour. On the day following the operation, a biliary vomiting developed which persisted until the patient's death on the tenth day. Autopsy showed perfect healing at the site of anastomosis and no peritonitis. The afferent loop of the small intestine measured 11 centimeters. The persistent vomiting was due to a mechanical defect at the site of the anastomosis. A spur formation was produced. The intestine was divided into a larger afferent loop which contained the pancreatic and biliary secretions and a much smaller efferent loop. The lumen of the latter was hidden under the overhanging margin of the gastric stomach. This case pointed out a very important technical error. The afferent loop evacuated its contents into the stomach while the lumen of the efferent loop was so placed that it could not drain the gastric contents. Vomiting was, therefore, the only means of emptying the stomach of the continuous reflux from the afferent loop. Thus attention was called to the fact that suturing of the viscera could be successfully accomplished but some of the mechanical features of the operation needed further elaboration.

In 1882 Luecke performed successfully the third gastrotomy. The fourth, fifth, and sixth cases were performed in the same year by Lauenstein Kocher (37) and Rydygier (72) respectively.

In 1883 Woelfler reported 2 modifications of his original operation. These were designed to overcome the difficulties encountered by Billroth in his first gastrotomy. In his first modification he suggested that that part of the lumen which belongs to the afferent branch should be so located that it will be covered for the greater part by gastric wall and that the efferent lumen

should communicate with the stomach through an opening having a diameter of 2 to 3 centimeters.

The second modification which he suggested was one in which reflux was placed on constriction of the lumen of the afferent limb by suture. Woelfler's ingenuity was exemplified later in his suggestion of still another operation. He detached the afferent limb from the efferent limb and inserted it a short distance lower down on the efferent limb. This formed a Y-shaped loop anteriorly. Later Roux made use of this principle but performed his operation on the posterior wall of the stomach. In the few operations that had been performed up to this date, no definite rule as to the length of the proximal limb of the intestinal loop was established. It was apparent that if per chance a loop of bowel close to the terminal ileum were applied to the stomach, the major portion of the digestive canal would be excluded from use. It was likewise apparent that if an extremely short loop were stretched around the transverse colon, it might cause obstruction of the colon or become obstructed itself. These considerations led to the performance of the first posterior gastrotomy.

On October 19 1883 Courvoisier performed a laparotomy for the removal of a pyloric tumor. The mass was irreducibly fixed and gastrotomy was decided on. The first loop of small intestine which presented itself appeared to be too distant from the stomach. Courvoisier decided to search for the duodenojejunal flexure. The omentum was severed transversely along the greater curvature of the stomach, an opening was made in the transverse mesocolon and the jejunum was found and pulled up. After isolating the site of anastomosis by silk sutures tied over split rubber tubes, one above and one below the isolated loop an opening 5 centimeters long on the antimesenteric margin of the bowel was made. The stomach was clamped off with a Gossauer clamp permitting a fold of the posterior wall of the stomach to remain exposed. This fold was also opened for a distance of 5 centimeters and both lumens were united. The entire operation lasted 2 hours and 50 minutes. The operation apparently was successful. On the eighth postoperative day the patient made the trip necessary to be presented at a meeting of the Swiss Medical Association at Olten. While there, she became ill, developed a fever and died on the thirteenth postoperative day. The autopsy showed a diffuse phlegmonous infiltration in the right rectus muscle and a diffuse peritonitis. A carcinoma of the pylorus was found. The anastomosis had healed perfectly. The stomach opening was in

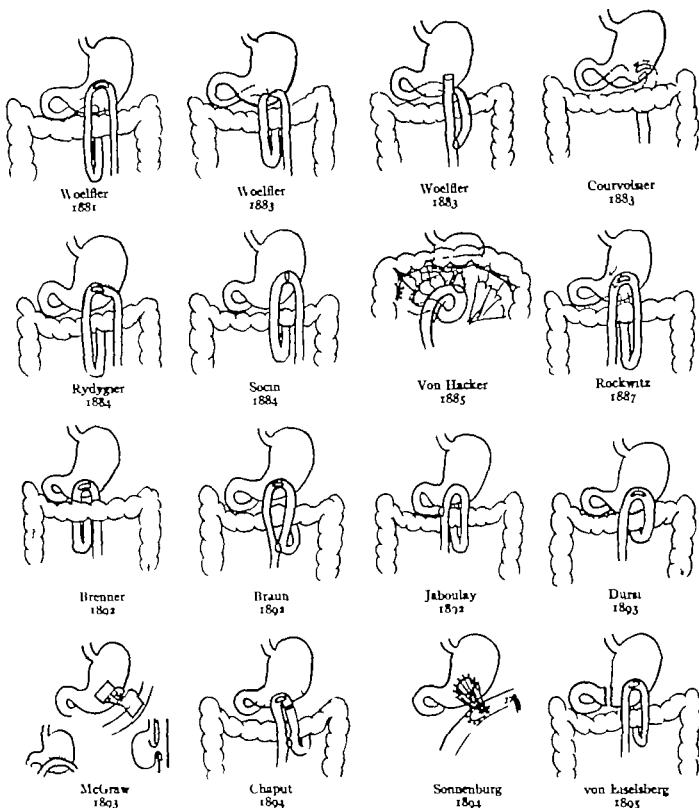


Fig. 1

the middle of the greater curvature and in the jejunum it was just below the duodenojejunal flexure.

In 1884 Rydygier reported the first gastroduodenostomy performed for pyloric stenosis due

to a duodenal ulcer. It is interesting to note that of the 7 gastroduodenostomies thus far reported only 2 patients survived—one Woelfler's and the other Luecke's. This operation therefore seemed too formidable to suggest its use in the treatment

of a benign lesion. Rydygier's patient was 20 years of age. He had an ulcer of 4 years' duration. The patient was treated conservatively for his vomiting by the use of a stomach tube. Improvement however was not satisfactory and it was thought a pyloric resection was needed. At operation, it was found that the ulcer was in the duodenum and the abdomen was closed. Rydygier thought that if a gastro-enterostomy were done stagnation would occur in the duodenum. He felt, too, that in view of the high mortality following the operation it would be better to treat the patient with a stomach tube. Under medical management, the condition continued unabated and the patient lost weight. In desperation another operation was decided on. An anterior gastro-enterostomy was done and the patient made a satisfactory recovery. Later in the same year Rydygier reported 2 additional cases, both successful.

In 1884 Socin of Basel performed a gastro-jejunoscopy on a patient who had had a previous pylorotomy. In the same year Ranschoff performed the first gastro-enterostomy in the United States. By 1885 18 cases had been published.

On March 22, 1885 Billroth (5) attached the jejunum to the posterior wall of the stomach after passing it through an opening in the transverse mesocolon without perforating the gastrocolic ligament. Although the patient died following this operation Billroth was not content to discard this method completely but suggested further study of the technical difficulties he had encountered. Von Hacker of Billroth's clinic made anatomical studies on cadavers in an attempt to determine the most favorable site for anastomosing the jejunum to the stomach. A study of the structure of the mesocolon in a number of cadavers revealed several thin avascular regions through which the jejunum could be brought to the posterior gastric wall. Following these studies the operation was performed on patients in the clinic. The results obtained with this new technique were not encouraging. These results were due probably to the nature of the disease—"carcinoma cachexia"—rather than to the technique of the operation.

In 1886 Morse performed the first gastro-enterostomy in England.

In 1887 Rockwitz reported 8 consecutive successful cases and emphasized the importance of selecting suitable cases. With reference to indications, he advised that gastro-enterostomy be employed in cases of stenosis of the pylorus and of the duodenum where a resection could not be carried out. In cases of carcinoma, it was to be employed in the presence of extensive adhesions

or glandular metastases, since resection was then contra-indicated. Some of his rules for performing this operation are of special interest. He advised against the separation of adhesions and isolation and manipulations of intestinal loops because he believed that they lead to infection and weaken the patient. He also suggested that any loop might be used for the anastomosis, and referred to Nothnagel's experiment (57) for determining the direction of peristaltic waves.

In 1889, Pozzi performed the first gastro-enterostomy in France (49).

In 1892, Braun reported work which he did in 1884. He performed isoperistaltic application of the jejunum to the stomach as was later recommended by Rockwitz. Lauenstein advised entero-anastomosis if vomiting of bile and pancreatic juice occurred too frequently in the postoperative course of patients who had been subjected to gastro-enterostomy. He, however, suggested that any intestinal loop might be attached to the proximal limb of the jejunum to relieve this condition. This was objected to by Braun because in some instances the terminal ileum was used with very unsatisfactory results. It was Braun's conclusion that when entero-enterostomy was indicated it should be performed between the afferent and efferent limbs of the loop used for the gastro-enterostomy. Jaboulay in 1892 suggested an anastomosis of the distal loop with the third portion of the duodenum so that the pancreatic and biliary juices would be carried away from the stomach.

One of the most troublesome complications of gastro-enterostomy was observed in Billroth's first case. This was the occurrence of a postoperative train of symptoms which have since been designated as "vicious circle" (17). The procedures suggested by Woelfler, Braun, Lauenstein, and Jaboulay were for the purpose of avoiding or relieving this complication. The principle underlying these methods was the prevention of reflux of intestinal contents through the gastro-enterostomy stoma.

In 1897 Roux reported his experience with 50 gastro-enterostomy cases performed as follows: Anterior antecolic, 8 cases; posterior retrocolic, 7 cases; Kocher's valve, 3 cases; retrocolic *en Y*, 29 cases; anterior antecolic *en Y*, 3 cases; anterior retrocolic *en Y*, 1 case; anterior retrocolic, 1 case. His mortality was 30 per cent. In the 29 cases in which he performed the posterior *en Y* operation, the mortality was 20 per cent. He preferred the posterior *en Y* operation because the opening was made in the most dependent part of the stomach and there was no spur, kink, or valve. In this operation, there was also no pressure on the colon.

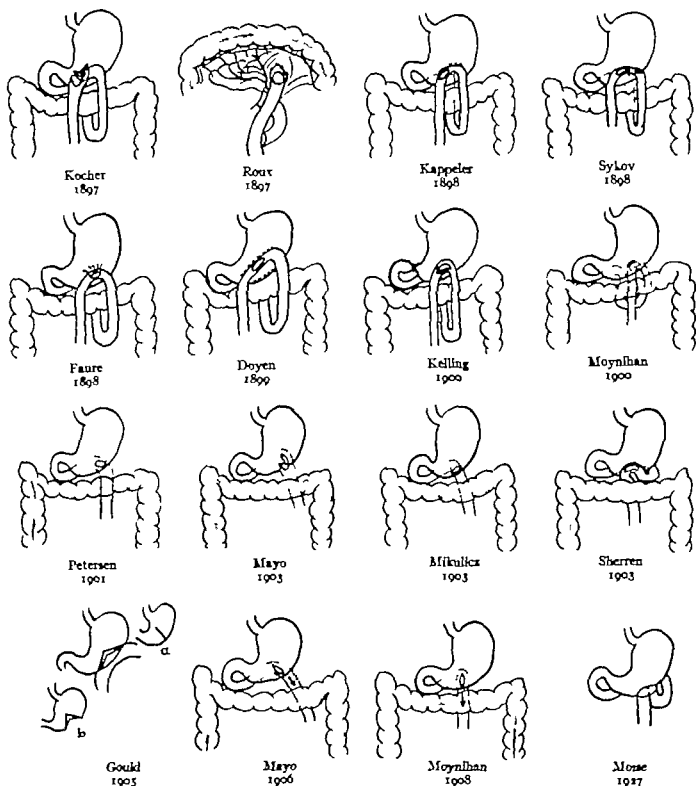


Fig. 1

The posterior retrocolic operation grew in favor and attracted the attention of many surgeons. It received a further stimulus through the anatomical studies made by Petersen on the relationship between the highest portion of the jejunum and the lowest portion of the stomach. He found that

it was possible to anastomose the jejunum with the stomach close to the duodenojejunal flexure without much tension. This obviated the necessity of a proximal loop and made it unnecessary to perform the *en Y* operation which was designed to accomplish the same purpose. In 1901,

Petersen's work was published from Czerny's clinic and its importance was recognized by surgeons throughout the world. It was adopted by the Mayo in this country, by Moynihan in England and by other large clinics. Aside from some minor modifications, the operation of Petersen is in substance the operation that is performed today.

The interval between 1881 and 1901 saw a group of operations that demonstrated the ingenuity of the surgeons of that day and the accompanying illustrations portray a number of these interesting procedures. In addition to the mechanical hook up difficulties experienced, there were the difficulties of avoiding infection and of maintaining the patency of the stomata. The danger of infection in those early days contributed liberally to failure. The incidence of infection was high because the operation was done commonly for malignant pyloric obstruction in the presence of a diminished or absent acidity of the gastric contents. Even today these cases do not fare as well immediately after operation as do those cases in which a benign obstruction is present. To overcome the possibility of infection, operations were devised from time to time in which the anastomosis was performed without opening the mucosa at the time of operation. Thus McGraw (45) in 1891 used an elastic ligature which was designed to cause necrosis eventually of the encompassed tissues and establish an opening between stomach and jejunum. Similarly Postnikow and Podreza used heavy silk ligatures. Souligoux used an angiotribe. Boari and Paul used caustics applied to the mucosa which caused it to slough through at a later date.

There were many failures due to closure of the stoma some time after operation. It was believed that this might be avoided by the use of artificial substances which would splint the mucosa until healing took place and at the same time insure the patency of the opening. Thus Senn described the use of decalcified bone plates in 1888. Robinson advocated raw hide plates in 1890. von Baracz used turnip plates in 1893 and during the same year Murphy used his famous balloon. In 1893 Mayo-Robson used the bone bobbin and in 1900 Credé advocated perforated silver plates. Many modifications of each of these methods have been recommended but practically all of these procedures have been discarded by present day surgeons.

The continued use of gastro-enterostomy has stimulated an interest in the anatomy and physiology of that portion of the gastro-intestinal tract related to this operation. Some of the pertinent facts will be reviewed briefly.

ANATOMY AND PHYSIOLOGY

The stomach is a muscular organ divided anatomically into 4 parts: fundus, body, antrum, and pylorus. The latter is not far from its lowest point and lies nearly in the midline of the body. As the stomach distends, it becomes more nearly horizontal by the elongation of the greater curvature. The pylorus passes to the right of the midline and relatively passes above the greater curvature. The gastro-epiploic artery lies at some distance from the greater curvature when the stomach is empty and sends its gastric branches to the anterior and posterior gastric walls. The arrangement of the blood vessels enables rapid distention of the stomach without interference with the blood supply (38). The lesser curvature is more fixed in position and can be divided into 2 parts: the perpendicular portion, which drops nearly vertically from the right margin of the cardiac orifice, somewhat to the left of the midline, and the horizontal or slightly curved portion, which turns sharply to the right and ends at the pylorus. This division of the lesser curvature corresponds to the line of separation between the antrum of the stomach to the right and the body of the stomach to the left.

With these gross external anatomical divisions of the stomach, there are internal anatomical differences. Bisection of the stomach through the greater and lesser curvatures shows that the antrum has a mucosal lining which is rougher, exhibits fewer rugae, and has a correspondingly lighter (pinker) color than the mucosal lining of the body of the stomach. The thickness of the wall in the antrum is greater and this thickness is due principally to the increased amount of muscle tissue, especially the circular fibers.

These gross anatomical differences are associated with physiological differences. The body of the stomach is the storing and digesting portion of the stomach. Here the greatest activity is shown by the mucosa whose numerous folds afford a large secreting surface. The antrum, conversely, is the active motile and grinding portion of the stomach. Here the greatest activity is exerted by the musculature. In the antrum the peristaltic waves arise approximately 4 times as frequently as they do in the body of the stomach. The difference in the muscular activity of the 2 portions of the stomach accounts also for the marked variations in intragastric pressure. The pressure in the fundus is low as compared to that in the antrum but even here there occur marked fluctuations.

In 1887 von Pfungen measured intragastric pressure on a boy with a gastric fistula. The pressure in the fundus varied only from 5 to 10 millimeters of mercury while in the region of the pylorus

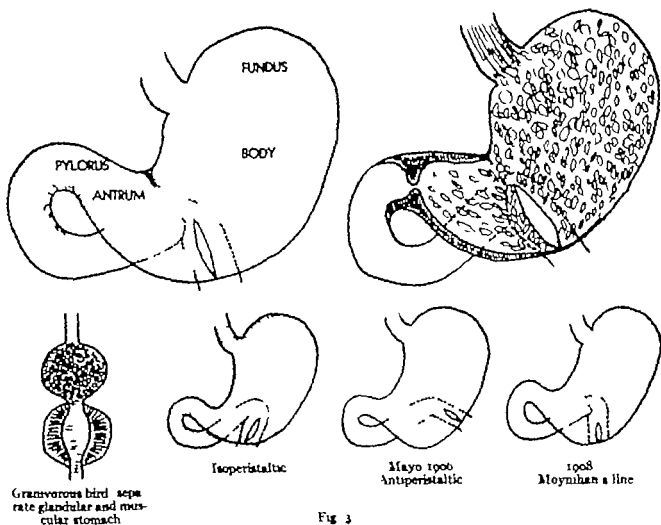


Fig. 3

rus it varied between 40 and 50 millimeters. Moritz also found that in the fundus the variations of pressure were from 2 to 6 centimeters of water while in the pyloric region the pressure rose to 60 centimeters of water.

The irritability of the antrum is greater than that of the body. Any trauma to the antrum will usually result in spasms of great intensity while this phenomenon is not noted in the body. Ivy has shown that when the antrum is traumatized in making a Pavlov pouch, the intensity of the spasm may be so great that the animals will die of starvation from the spastic obstruction. This does not occur however when the surgical procedure is confined to the body of the organ. The distribution of the vagus and sympathetic nerves, those especially associated with muscular activity is probably greater over the antrum than over the body of the stomach. C. H. Mayo (37) records the fact that X-ray observations have shown that an ulcer that is situated in the antrum will produce more spasm than an ulcer that is located at the pyloric end of the stomach or of the duodenum.

The purpose of this brief exposition of the anatomy and physiology of the stomach is to point out the marked differences that exist between the antrum and the body—differences that are so great that one may consider them functionally as 2 independent organs. In granivorous birds there are present 2 distinct divisions of the stomach (22). One is known as the secretory stomach and the other the motor stomach (Fig. 3). While these divisions are not so pronounced in mammals yet in some of the lower forms the divisions are easily recognized. These differences may also account for the conflicting reports in experimental and clinical work. In 1905 Cannon and Blake showed that if the pylorus were patent the gastric contents would not leave through the artificial stoma but would leave by way of the pylorus. Berg made similar observations and reported them in 1913. Their experiments were performed on dogs and cats. It has been repeatedly shown that in humans this is not always true. Numerous X-ray examinations of patients with gastro-enterostomies show that in a high per cent of cases the meal will leave through the gastro-enterostomy stoma.

even though the pylorus is patent (38). In many cases the meal will leave by way of both openings. To be sure that the food would leave through the newly formed stoma Kelling in 1901 and Mayo (42) in 1902 suggested that the pylorus be excluded by plication without division of its continuity. A similar interruption of the pyloric lumen was carried out in 1895 by von Eselsberg who in a case of irremovable pyloric carcinoma, divided the stomach proximal to the tumor and then closed both ends by suture. This procedure was designed not so much to insure the passage of the gastric contents through the new stoma as to prevent the spread of the carcinoma in the direction of the new stoma. In 1914 Hartman showed that the location of the stoma had much to do with the path taken by the meal in leaving the stomach. If the stoma is placed too far away from the pylorus i. e. far up on the body of the stomach the new outlet is so remote from the driving portion of the stomach that no sufficient increase in intragastric pressure can possibly influence the movement of food through the new opening. Hartman quotes Tuffier who states "I remind you how easy it is to observe on a dog, making use of *N. rays*, that everything passes through the pylorus, because we know when operating on a dog that the new pylorus can only be placed at a distance of 25 centimeters from the normal pylorus and not less. Those who placed the stoma nearer the pylorus observed different *N. ray* findings."

Thus we are led to a discussion of the position the stoma should occupy in the operation of gastropylorostomy. It would seem from the foregoing that the only logical location would be at a point just proximal to the antrum. Thus it would lie outside of the grinding highly active, irritable portion of the stomach and yet at about the most distal portion of the body of the stomach. This location also would receive the benefit of the greatest intragastric pressure without interfering with the activity of the antrum. The location of the stoma in the antrum is obviously illogical since it acts in itself as a trauma to this highly sensitive portion of the stomach, interferes with its contracting ability and by its spasm may occlude the lumen of the new stoma. The location of the stoma in the body of the stomach will of course decrease its suitability in direct proportion to its distance proximal to this juxta-antral line.

With the stoma located just proximal to the antrum, the direction would of necessity be vertical, i. e. running from the lesser to the greater curvatures. The line along which the stoma should be placed is described by Moynihan (54) as being in line with the esophagus. It will be found that

when traction is made on several points along the greater curvature, a fold will appear at one point which is in line with the right border of the esophagus. The stoma should be placed about 1 inch proximal to this line.

The size of the stoma should, of course, be adequate. Experience has shown that an opening approximately 2½ inches in length in the jejunum and stomach is sufficient for satisfactory evacuation of the stomach.

There are apparently valid objections to having the long axis of the stoma placed in the longitudinal direction of the stomach. Such an opening produces a trough which results in the constant presence of residual gastric contents below the level of the stoma. Incidentally a longitudinal incision along the greater curvature results in the cutting across of many branches of the gastropyloric artery at the site of the stoma while a vertical incision runs almost parallel to these vessels. Since drainage is one of the most beneficial results of this operation, the stoma should run down to the greater curvature so that the lowest point of the stoma lies at the lowest point of the stomach. Mayo in 1905 was so impressed with this detail that he advised carrying the posterior opening past the greater curvature on to the anterior wall of the stomach.

Moynihan early in his work suggested that the opening in the posterior wall of the stomach be inclined downward and to the right (isopneustic). Mayo (40) however advocated that the jejunum be applied obliquely to the left almost at a right angle to Moynihan's line. The basis for this suggestion was that normally the jejunum lies to the left of the vertebral column in a fossa above the left kidney. Further observation led Moynihan (52) to state

"To say that the jejunum takes a certain line normally from the flexure is probably neither accurate nor reasonable. The ligament of Treitz suspends the jejunum thus allowing it to go to the left or right without twisting. One line is probably as good as another or any line between them as good as either provided no twist is made in the gut. Just as there is no natural direction of the jejunum so there is no best line for the anastomosis."

The location of the stoma in the small intestine should be on the antimesenteric side of the jejunum close to the ligament of Treitz. The anatomical investigations of Petersen in Czerny's clinic at Heidelberg and the recent investigations of MacLeod are of interest because they point out the relationship that exists between the first portion of the jejunum and the posterior wall of the stomach. MacLeod noted that that part of the jejunum which lies below the duodenal flexure as

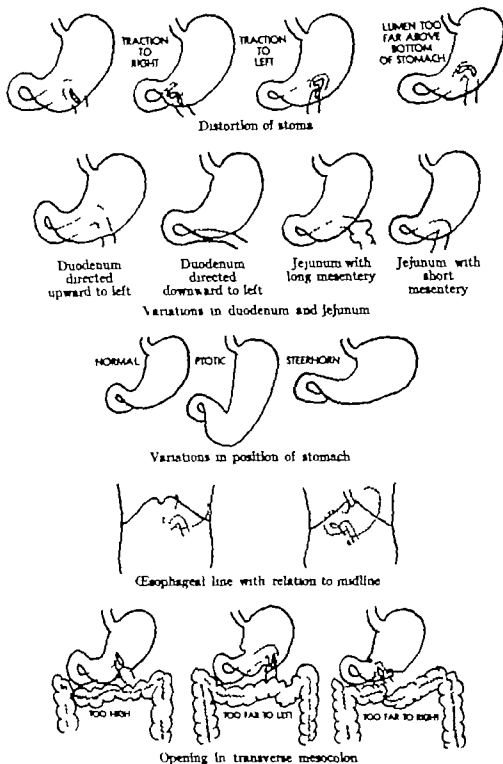


Fig. 4.

it passes either through the transverse mesocolon or immediately between it and the posterior abdominal wall is constant in position regarding its level and lies either in front of or to the left side of the third lumbar vertebra. In some cases of general visceroptosis it was placed as low as the lower border of the fourth but it was usually well above the level of the greater curvature. The position

of the lowest part of the stomach is not constant but lies somewhere on the greater curvature between 2 points, one of which lies $1\frac{1}{2}$ inches proximal to the pylorus and the other 2 inches to the left of the midline. He further demonstrated that by applying traction on the greater curvature the lowest point of the stomach can be located. This usually lies to the left of the mid-colic artery but

in a few it is to the right. The jejunum where it crosses the greater curvature runs sharply downward, in most cases across or just to the right of the most dependent part of the stomach and in a lesser number of cases slightly obliquely to the left. MacLeod found that in every case there is ample room for anastomosis with a satisfactorily large stoma.

Mikulicz also suggested an operation with a very short loop so as to avoid the afferent limb which was responsible for the train of symptoms known as vicious circle. He demonstrated to the Mayos at Rochester in 1903 a method of application of the jejunum to the stomach that was based on the important observation that the duodenojejunal angle is always above the greater curvature of the stomach and that the jejunum has a vertical course downward where it crosses the greater curvature. In this work Mikulicz used a transverse incision in the jejunum. He effected an anastomosis with the stomach which was satisfactory except for the fact that the transverse opening in the jejunum was too small for adequate drainage of the stomach. This has been abandoned in favor of the longitudinal incision in the jejunum—a procedure which was emphasized by Petersen in 1901.

Occasional variations in the anatomy of the stomach, duodenojejunal angle, and transverse mesocolon may influence the exact location of the site of anastomosis. Fauchild has emphasized the transverse position of the stomach in a stout individual as contrasted with the longitudinal position in the slender ptotic individual. The jejunum may have either a long or a short mesentery or it may arise (rarely) below the stomach or it may arise at a considerable distance to the left. Thus it seems, the best plan to follow is that suggested by Moynihan and emphasized by Wilkie that the relation between the jejunum and stomach be determined within the abdomen at the time of operation before the anastomosis is made so that no distortion is produced by the anastomosis.

Considerable attention should be given to the selection of the site of the opening in the transverse mesocolon in performing posterior gastrojejunostomy. Within its folds lies the colica media artery whose injury may result in necrosis of the transverse colon. The opening in the transverse mesocolon should be made in an avascular area to the left of this important vessel. In stout individuals the transverse mesocolon may be short, while in slender individuals it may be long. Hence its relation to the stomach and jejunum should be determined with the organs in the abdomen before anastomosis is attempted. Traction by a short

mesocolon may seriously interfere with the functioning of the new stoma. The opening in the mesocolon permits communication between the lesser and greater peritoneal cavities.

Herniation of viscera from the greater sac to the lesser sac may occur if the edges of the opening in the mesocolon are not fixed to the stomach or jejunum. In the early days of this operation, the opening was occasionally sutured to the stomach because it was learned that contraction of the opening about the stoma could occur (43). It was found later that herniation into the lesser peritoneal cavity was common when this suturing was not done. Von Hacker originally sutured the edges of the slit to the stomach and even as late as 1901 Robson and Moynihan suggested that this might be advisable in order to prevent contraction of the slit with consequent narrowing of the jejunum as was noted by Czerny. In 1903, Moynihan (53) had his first experience with herniation into the lesser peritoneal cavity in a case in which he had failed to close the opening in the transverse mesocolon. Subsequently he advocated that this be done in every case. A similar experience by W. J. Mayo (39) resulted in further emphasis on the importance of this procedure. While Moynihan suggested that the slit be sutured to the jejunum, there is a possibility that this may result in obstruction as was recently reported by Torrance. Mayo suggested that the slit be sutured to the site of the anastomosis but in 1912 (39) he reported that in 2 cases where a fat mesocolon was encountered, a constricting band developed which required a second operation for its relief. In his later cases, no difficulties were encountered when the raw edges of the slit were tucked into the lesser peritoneal cavity. This was done by a special application of the suture slightly removed from the raw edge thence through the stomach and jejunum where they lie approximated by suture.

MacArthur offered an important suggestion when he advocated that the slit be sutured to the stomach before the stomach was approximated to the loop of the jejunum for anastomosis. It is obvious that following the anastomosis, the posterior aspect of the gastro-enterostomy is not easily accessible and undue traction may be necessary in order to place the posterior sutures. When clamps are used, he advises that the sutures be placed after the clamp is applied to the stomach and before this clamp is approximated to that on the jejunum.

The use of clamps to facilitate operations on the intestinal canal was described by T. Kocher (58) in 1880. He devised these instruments for intesti-

nal resection but their use for other surgical procedures in intestinal work was made apparent. In 1893 W. A. Lane made use of clamps with curved flat blades that were devised by T. Smith for abdominal operations. By 1895 the use of clamps became well established and they were illustrated in the textbook of surgery by Doyen. In 1900 H. Littlewood of Leeds described the use of rubber covered Doyen clamps in performing gastrojejunostomy. Moynihan early made use of them and it is due probably to his extensive writing that they have become popularized. His demonstration of their use to the Mayos in 1903 at Rochester was the first time they were used in this country. It should be noted however that clamps are not considered an absolute necessity and many surgeons prefer to effect the anastomosis without their use. In obese individuals, those with a short transverse mesocolon or a short mesentery of the jejunum, the use of clamps often is made almost impossible.

The type of suture material used in gastrojejunostomy has been a controversial subject for some time. Increasing experience has shown that the use of absorbable material is probably most satisfactory. The presence of non-absorbable suture material which may ulcerate through the wall of the viscus and result in secondary hemorrhage or chronic ulceration has led to the suggestion that this type of suture be discarded (77). In the experience of many surgeons there have occurred instances when on reopening the stomach non-absorbable suture materials were found to hang from the site of anastomosis in the lumen of the jejunum. There are some who still prefer the use of silk or linen for all layers of the anastomosis. Others are divided in their selection, some use catgut for the mucosa and linen or silk for the seromuscular layer or vice versa. The use of interrupted non-absorbable sutures to re-enforce the anastomotic sites of particular stress has been rather widely adopted. These are placed as interrupted sutures in the seromuscular layer. More liberal use of these interrupted sutures is made in carcinoma of the stomach or other cachectic states.

The depth of penetration of the suture is of importance. The toughest layer of the intestinal canal is the submucosa and it is into this layer that the seromuscular suture must penetrate if it is to serve its purpose best. It is practically impossible to make this an aseptic suture since the mucosal glands dip into this layer to such an extent that an adequate stitch must of necessity penetrate some of these glands, at least in the jejunum. It has been aptly stated by Sweet that more lives are lost because the suture did not penetrate deeply

enough than because of infections resulting from a deep penetration of the suture. The peritoneum may well care for the slight infection engendered by a septic suture but may be powerless against a leak occasioned by the separation of the approximated viscera which occurs as a result of inadequate suturing. It has been found satisfactory to ligate the vessels traversing the submucosa at the site of the stoma in the stomach after the superficial layers have been incised. The larger vessels must be ligated if postoperative hemorrhage is to be consistently avoided. The lock stitch which usually is employed as a hemostatic suture, although adequate to control the capillary oozing of the incised mucosa of the stomach and jejunum is not adequate for hemostasis of the larger gastric vessels that are severed. This is especially true when clamps are used to fix and approximate the loops of stomach and jejunum for anastomosis. As soon as the clamps are removed and the viscera released from their fixed position of extension, muscular contractions tend to decrease the size of the stoma but the fixed suture now has redundant loops which no longer compress the vessels within their grasp.

It should be noted also that suturing should be for the sole purpose of making adequate approximation of the tissues, thus permitting nature to effect a healing of the approximated structures. When excessive traction is made in placing the sutures, strangulation of the tissues ensues with resulting necrosis and sloughing. This may result not only in secondary hemorrhage but also in leakage into the peritoneal cavity.

At the time of incision into the stomach and jejunum the free secretions should be removed at once by gentle sponging. These secretions are rich in enzymes, which if allowed to be spread about may favor rapid absorption of the sutures. When the placing of sutures has been completed it is essential that there be no oozing of blood from the suture line and that all raw surfaces be adequately covered. This will prevent the formation of scar tissue which might constrict or distort the stoma. Before the operation has been concluded a careful inspection and survey should be made to establish (1) the correct mechanical arrangement of the anastomosis (2) the absence of twists or kinks (3) the patency of the stoma. Before the abdomen is closed the viscera are so arranged that the new stoma hangs free to the left of the vertebral column in order that the site of anastomosis will not be compressed between the anterior abdominal wall and the vertebral bodies. The greater omentum is replaced over the under surface of the anterior abdominal wall and closure of

the abdomen is made by layers without drainage. The posterior sheath of the rectus muscle and peritoneum may be closed by a continuous suture but the anterior layer of the rectus sheath had probably better be closed in most instances with interrupted sutures.

BIBLIOGRAPHY

1. VON BARACK, R. Turnip plates instead of Senn's bone plates. *Arch f. klin. Chir.* 1892, 44, 580.
2. BERN, A. A. The influence of gastro-enterostomy on gastric and duodenal ulcers. *J. Am. M. Ass.* 1913, 60, 831.
3. BILLROTH, T. Reports on Billroth's operation. *Wien. med. Wchnsch.* 1881, 31, 595, 634.
4. Idem. Reported by Woelfler. A. (83).
5. Idem. Reported by von Hacker (20).
6. BOARI, A. Two stage operation with cruetica. *Clin. Chir.* 1897, p. 290.
7. BRAUN, H. Gastro-enterostomy and entero-anastomosis carried out simultaneously. *Arch f. klin. Chir.* 1892, 45, 36.
8. BREYER, A. Technique of gastro-enterostomy. *Wien. klin. Wchnsch.* 1893, 5, 375.
9. CANNON, W. B. and BLACK, J. B. Gastro-enterostomy and pyloroplasty. *Ann. Surg.* 1905, 41, 5.
10. CRUICK, Described in *Handbook of Practical Surgery* p. 98, on Bergmann, Bruns, Mikulicz. Stuttgart f. Cohn, 1900.
11. COURVOISIER, L. G. Gastro-enterostomy according to Woelfler in case of inoperable cancer of pylorus. *Death. Zentralbl. f. Chir.* 1883, 10, 704.
12. CRENS, Gastro-intestinal anastomosis. *Zentralbl. f. Chir.* 1900, 27, 65.
13. DODD, E. L. *Surgical Treatment of Diseases of Stomach and Duodenum*. Paris: Masson & Co. 1895.
14. VON EISENBERG, A. F. Satisfactory of inoperative pyloric structure, etc. *Arch. f. klin. Chir.* 1895, 50, 910.
15. FAIRCHILD, F. R. Obstruction following gastro-enterostomy its mechanical factors. *Calif. & West. Med.* 1910, 33, 800.
16. FAURE, J. L. New method of gastro-enterostomy by means of invagination. *Rev. de gynéc. et de chir. abd.* 1898, 81.
17. FOWLER, G. R. The "vicious circle" following gastro-enterostomy. *Ann. Surg.* 1903, 36, 395.
18. GOULD, A. H. A new method of performing gastro-enterostomy. *Boston M. & S. J.* 1905, 62, 66.
19. GUMPERT, C. and von WINGWARTER, A. Partial gastric resection. *Arch. f. klin. Chir.* 1896, 19, 347.
20. VON HACKER, V. R. Discussion and statistics on gastric resection and gastro-enterostomy. *Arch. f. klin. Chir.* 1885, 32, 610.
21. HARTMAN, H. Function of the gastro-enterostomy opening in cases of pernicious pyrosis. *Ann. Surg.* 1914, 59, 833.
22. HENNINGTON, G. S. *The Anatomy of the Human Peritoneum and Abdominal Cavity*. Philadelphia: Lee Bros. & Co. 1903.
23. IYER, A. C. Personal communication.
24. JABOULAY, M. Gastro-enterostomy. Jejunoduodenostomy. Resection of pylorus. *Arch. prov. de chir.* 1893, 50, 1-23.
25. KELLOGG, G. Surgery of the stomach. *Arch. f. klin. Chir.* 1900, 62.
26. KOCHER, T. *Text Book of Operative Surgery* p. 200. New York: Macmillan Company. 1903.
27. Idem. Quoted by Monoprofit, A. (40).
28. Idem. On a method of bowel resection, etc. *Zentralbl. f. Chir.* 1880, 30, 465.
29. Idem. *Text Book of Surgery*. Jena: G. Fischer. 1897.
30. LACE, W. A. Clamp forceps in biliary operations. *Lancet*, 1893, 2, 813.
31. LAUGENSTEIN, C. Verhandl. d. deutsch. Gesellsch. f. Chir. 1883, 12, 25.
32. LITTLEWOOD, H. Intestinal suture by means of continuous catgut suture and evulsion of mucous membrane. *Lancet*, 1901, 1, 1817.
33. LUKINS, A. Quoted by Woelfler (86).
34. MACARTHUR, A. A. Personal communication.
35. MACLEOD, O. Some anatomical and mechanical factors in posterior gastro-enterostomy. *Lancet*, 1906, 211, 490.
36. MANDERLUTZ, J. G. *Clinical Surgery* Vol. 2, p. 439. et seq. Paris, 1894.
37. MAYO, C. H. Discussion on gastric surgery. *Ann. Surg.* 1909, 49, 543.
38. MAYO, W. J. Review of five hundred cases of gastro-enterostomy. *Ann. Surg.* 1905, 42, 21.
39. Idem. Management of opening in transverse mesocolon. *Ann. Surg.* 1913, 55, 908.
40. Idem. Technique of gastrojejunostomy. *Ann. Surg.* 1906, 43, 537.
41. Idem. Duodenal ulcer—a critical review of 58 operated cases with some remarks on gastrojejunostomy. *Ann. Surg.* 1904, 40, 900.
42. Idem. Operations upon the stomach. *Ann. Surg.* 1903, 36, 42.
43. Idem. Complications of gastro-enterostomy. *Ann. Surg.* 1902, 35, 231.
44. MAYO-ROBINSON, A. W. The Bone Bobbin. *Brit. M. J.* 1893, 1, 688.
45. MCGRAW, T. A. Upon the use of elastic ligature in surgery of the intestines. *J. Am. M. Ass.* 1911, 16, 685.
46. Idem. On a method of making intestinal anastomosis which will prevent contraction of the orifice. *Ann. Surg.* 1893, 18, 33.
47. MERTZ, J. Quoted by Mayo (58).
48. MONROE, T. S. et al. A method of gastro-enterostomy with a transverse jejunal incision. *Surg. Gynec. & Obst.* 1907, 44, 824.
49. MOVEMONT, A. Gastro-enterostomy. *Gaz. med. de Par.* 1904, 75, 78, 85.
50. MOURRE, Studies on the motor activities of the stomach. *Ztschr. f. Biol.* 1895, 32, 359.
51. MORSE, Quoted by Monoprofit, A. (40).
52. MORTIMER, B. O. A. Direction of the jejunum in the operation of gastrojejunostomy. *Ann. Surg.* 1906, 47, 481.
53. Idem. Personal communication.
54. MORTIMER'S LIVER. Quoted by M. J. W. J. (53).
55. MURPHY, J. H. Cholecysto-entero-anastomosis, etc. *Med. Rec.* 1903, 42, 665.
56. NICOLAIDIS, C. Quoted by Woelfler A. (86).
57. NOTKOWSKI, H. Experiments on physiology of the intestines. *Arch. f. path. Anat.*, 88, 881.
58. OUTLAND, J. H. O. SULLIVAN, E. H. and CLARKSON, L. Study of the mechanics of the stomach after gastro-enterostomy by means of the X-ray. *Surg. Gynec. & Obst.* 1913, 17, 175.
59. PAUL, F. T. New method of gastro-enterostomy. *Brit. M. J.* 1906, 1, 1437.
60. PRATT, J. Memoir of tumors of the stomach by gastrojejunostomy. *Gaz. d. hôp.* 1879, 52, 473.

61. PETERS W. Anatomical and surgical studies in gastro-enterostomy. Beitr. z. klin. Chir. 1901 30 59.
62. VON PRUNGEN. Quoted by Hartman H (31).
63. POHLER, A. Gastro-enterostomy and entero-anastomosis. Arch. f. klin. Chir. 1898, 57 358.
64. POSNIAKOW P. The two-stage gastro-enterostomy. Zentralbl. f. Chir. 1892 19 1018.
65. RAKONOFF, J. Case report. Med. News, 1884 45 578.
66. ROBINSON E. H. The rawhide plate. New York M. J., 1890, 52 430.
67. ROBSON and MONTGOMERY. Diseases of the Stomach. New York Wm Wood & Co. 1901.
68. ROCKWITZ, C. Gastro-enterostomy. Deutsche Ztschr. f. Chir. 1887 25 502.
69. ROUX, C. Gastro-enterostomy. Rev. de gynéc. et de chir. abd., 1897 1 67.
70. RYDQUIST, K. Quoted by Monprofit A (40).
71. Idem. The first case of gastro-enterostomy in stenosis of the duodenum as the result of ulcer. Zentralbl. f. Chir. 1884, 11 63.
72. Idem. A case of gastro-enterostomy. Zentralbl. f. Chir., 1885, 10 241.
73. SCHEM N. Enterorrhaphy its history technique and present status. J. Am. M. Ass. 1893 21 215.
74. SHEPARD J. CHOTEC—System of Surgery. Vol. 2, p. 409. New York Funk & Wagnalls, 1905.
75. SOCHIN A. On stomach surgery. Cor. Bl. f. schwed. Verh. 1884, 14 513.
76. SONNENBURG. Reported by SCHROETER F. On gastro-enterostomy. Deutsche Ztschr. f. Chir. 1894, 38 196.
77. SORESEN A. L. Secondary ulcers of the stomach and jejunum. Formation of calculi around unabsorbable material used in suturing the intestinal mucosa. Ann. Surg. 1915 61 328.
78. SOULIGNOUX, M. Operation in two stages with angiotribe. Semaine méd. 1896 16 283.
79. SWART J. E. Technique of surgery of gastro-intestinal tract. Surg. Gynec. & Obst. 1927 44 811.
80. SYKOFF W. Valvular method for gastro-enterostomy. Arch. f. klin. Chir. 1898 56 418.
81. TORPACA L. Incarceration of anastomotic loop in transverse mesocolon. J. Am. M. Ass., 1932 97 2173.
82. TURPIN, M. On ulcer of the stomach. Cong. franc. de m. d., 1907 2 137.
83. D'URUS. Gastro-enterostomy for stenosis of pylorus. Zentralbl. f. Chir. 1893 20 448.
84. WILKIE, D. P. D. Gastric surgery. Edinburgh M. J. 1919 23 319.
85. WOELFLER, A. Gastro-enterostomy. Zentralbl. f. Chir., 1881 45 05.
86. Idem. Verhandl. d. deutsch. Gesellsch. f. Chir., 1883, 18 72.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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DRAINAGE OF THE PERITONEAL CAVITY AND INTESTINAL OBSTRUCTION

ACUTE intestinal obstruction is a very grave malady. Exclusive of strangulated hernia the average mortality is around 50 per cent. Adhesions are the largest single factor in bringing about this malady and the adhesions are due chiefly to either infection or drainage material left temporarily in the peritoneal cavity. One of the most difficult decisions that a surgeon is called on to make is to differentiate between paralytic ileus and mechanical obstruction as a post-operative complication of the acute surgical abdomen complicated by peritonitis and treated by drainage. Operative procedures for paralytic ileus are usually not only futile but harmful, but to fail to relieve acute mechanical obstruction promptly is to rob the patient of his chance of life. Altogether the problem is a most harassing one.

Closure of the infected abdomen without drainage is against tradition custom and common sense on the other hand, the placing

of drainage material where it comes in contact with loops of small intestine is to invite obstruction, either as an early or late mishap or to condemn the patient to an uncertain period of partial disability caused by angulation due to adhesions and these adhesions are often the one thing that spoils an otherwise successful operation.

There is experimental and clinical evidence that drains left in the peritoneal cavity are soon sealed off and there is also abundant proof that the peritoneum is a very efficient tissue in taking care of its own difficulties. This is especially true of infections, provided the cause of the contamination is removed and the door closed to further leakage. When gynecologists began to close the abdomen after removal of acutely infected pelvic organs, many surgeons were aghast and it soon became evident that leakage following intestinal suture was more likely to occur if drains came in contact with the suture line.

Drainage material placed in the peritoneal cavity cephalate to the level of the transverse colon is not so likely to cause obstruction because the jejunum and ileum are usually found caudal to this level. For this reason acute obstruction is not a common complication of drainage following operations on the biliary duct apparatus, the liver pancreas, duodenum, or stomach.

The solution of the problem, in part, is to place as little drainage material as possible where it is likely to come in contact with coils of small intestine. In draining a walled-off peritoneal effusion the risk of obstruction is not great. To close the abdomen, however in the presence of peritonitis seemed a fool

hardy thing to do, but less and less drainage was being used and, being harassed by the imminence of obstruction the writer several years ago, began to close the abdomen where early peritonitis was present at operation. My opinion is based on 90 patients with early diffuse peritonitis occurring in about 600 cases of appendicitis. A satisfactory classification of peritonitis from the standpoint of treatment is to divide these cases into three groups.

1 Early peritonitis whether localized spreading or diffuse, whether serous, seropurulent, or purulent, irrespective of the infecting organism and without regard to whether the appendix which is usually at fault is catarrhal thrombotic, gangrenous or perforated. The essential thing in this group is that the peritonitis is an early one—that is that the gut is still smooth and glistening and not markedly distended or discolored and that the coils of intestine are not adherent. In this group we carefully remove the appendix, with a minimum of handling through a McBurney incision suck out the liquid exudate and close the peritoneum without drainage. We usually drain the subcutaneous fat. We have had no serious mishap in this group.

2 Localized collections of pus within the peritoneal cavity so called pelvic, appendicular, subhepatic or subphrenic abscess. These walled-off effusions are drained. There were 20 of them and all recovered.

3 Late diffuse peritonitis with widespread adhesions between the different abdominal viscera surrounding multiple pockets of pus distended, discolored, and cedematous intestine, a board-like abdomen rapid pulse, anxious features dehydration and disturbance in the acid base balance. These were all drained and all of the fatalities were in this group 10 deaths in 30 patients.

This classification gives a good working basis and corresponds fairly well with the

British manner of indicating the seriousness of acute appendicitis by using the time factor 1 day, 2 day, 3 day etc. The peritoneum has a very remarkable defensive mechanism which apparently reaches its maximum efficiency when not disturbed by wide incisions, rough or prolonged handling, or the presence of drainage material, provided the cause of infection is removed and postoperative leakage controlled.

ARTHUR M. SHIPLEY

CARCINOMA OF THE BLADDER

THE successful treatment of carcinoma is dependent on its early recognition its situation, its cell differentiation its accessibility, and on its tendency to metastasize. Carcinoma of the bladder is unique in that all of these factors apply very definitely yet distinct progress in its management can hardly be said to have occurred for the past several years.

Symptoms of the disease become manifest soon after its inception, but the patient often disregards Nature's warning because of fear or timidity. It is difficult to understand why a person will consult his physician if blood is vomited but will attribute blood in his urine to a cold to bad food recently eaten or to some unusual strain, yet, though it is not diagnostic, bloody urine is one of the earliest signs of carcinoma of the bladder. Statistics in some institutions show that the average duration of symptoms prior to admission for treatment is 2 years. Obviously if this period is not reduced, the number of inoperable malignant lesions will continue to increase. If small lesions amenable to transurethral surgery are disregarded it is a matter of record that approximately 25 per cent of the major malignant lesions when first seen are inoperable.

Cell differentiation in a vesical carcinoma is a reliable index in estimating the ultimate

prognosis and is an aid in formulating the method of surgical attack. Tumors whose cells are highly differentiated are growing slowly so that there is not the tendency to invade the wall of the bladder or to extend beyond it. In fact many of such lesions are papillary or pedunculated and these lend themselves particularly well to transurethral attack. Likewise some of the more extensive lesions can be treated unless there is some other complicating condition such as obesity associated with recent coronary thrombosis. In the latter instance I feel that one can remove the growth more completely by the suprapubic or transvesical approach. Furthermore, a more satisfactory investigation of the vesical wall and adjacent mucosa can be made and the presence or absence of metastasis although rarely seen with this grade of carcinoma, ascertained. Accordingly the prognosis can be more wisely estimated.

Tumors whose cells are less differentiated are more malignant and as a rule invade the wall of the bladder early. They tend to ulcerate and produce considerable bleeding and they frequently are associated with necrosis and infection. Malignant lesions of this type in any hollow viscus are always a serious surgical problem and the prognosis must usually be guarded. The problem immediately becomes more complicated when the lesion involves the natural orifices of associated organs. As an example a small ulcerating malignant lesion of the pylorus may easily be resected but it is a much more difficult and serious situation should even a smaller lesion involve the ampulla of Vater. The same is true in the urinary bladder most unfortunately however these ulcerating highly malignant lesions are often situated around one or both ureteral orifices and the internal sphincter of the bladder. When the malignant lesion involves both ureters it probably is inoperable.

Involvement of a ureter immediately brings up the question of conservation of the affected kidney. Reimplantation of the ureter following segmental resection increases the mortality approximately 20 per cent but this mortality can be reduced by 50 per cent if the ureter is only ligated and dropped back. The latter procedure is applicable only when there is a sound kidney and free ureter on the opposite side. The fate of the kidney with a reimplanted ureter is much debated and offers an excellent field for investigation.

Randall recently observed that a kidney may cease to function if a malignant lesion is situated near the ureteral meatus. The answer to the high mortality following reimplantation may be partly contained in Randall's observation. If this observation is confirmed by others early diagnosis and treatment should assume increasing importance since a high percentage of rapidly infiltrating tumors as well as highly differentiated tumors occur in close proximity to the ureteral meatus. In fact, one of the most frequent and vulnerable points of origin is just above the meatus and directly over the intramural portion of the ureter so that early partial obstruction of the ureter at least, may occur although the meatus may be free from involvement. The rapidity with which involvement occurs depends largely on the cellular differentiation.

Fortunately many vesical tumors are essentially highly differentiated frequently multiple and pedunculated. Transurethral resection of the tumor and electrocoagulation of the base or the application of radium as indicated are the rule for such lesions. Some of the less differentiated more invasive tumors may occasionally be adequately handled by the same principle but the prevailing opinion of urologists in general is that these lesions should be attacked by the transvesical approach, since the tumor is more accessible and its local re-

removal or destruction is therefore more likely to be complete. This is particularly true if the ureter is involved and segmental resection is indicated. Tumors involving the dome and posterior wall are also quite accessible and lend themselves readily to resection.

It would be a distinct advantage in formulating the type of treatment were it possible to ascertain clinically the presence or absence of metastasis. If metastasis has occurred in the majority of cases only palliative treatment is indicated. The frequency of metastasis in carcinoma of the bladder is about the same as for carcinoma elsewhere and according to Spooner conforms to the plan set forth by Broders, in his classification of epitheliomata, that the less differentiated tumors metastasize early. He has found that the incidence at necropsy of metastasis of vesical carcinomata is 29 per cent which indicates that it is much more common than is generally believed which is contrary to the opinion that vesical carcinomata metastasize late.

From the surgical point of view these findings are extremely important, though somewhat discouraging because rarely can an extensive operation for carcinoma of the bladder be done with removal of the involved lymph nodes without a high mortality. Future development in roentgen therapy may

offer a more hopeful prognosis. Inability to determine clinically the presence of metastases is stressed by Spooner. He noted that in 65 per cent of cases in which metastasis was present the condition was regarded as amenable to surgical treatment, when dealing with a large infiltrating lesion therefore the foregoing data are suggestive at least that the peritoneal cavity should be opened and careful exploration performed before a radical resection is carried out which at best is only temporary if lymph nodes are involved. The clinical significance regarding the possibility of metastasis, malignancy of high grade and a large lesion should be emphasized in a case with symptoms present for one year.

The value of a follow up system in cases of carcinoma of the bladder cannot be overestimated. Recurrence may take place following any method of surgical treatment but if the recurring lesions are discovered routinely before they produce symptoms, many of them can be destroyed transurethrally and a good result obtained. For instance in a recent series of 67 cases in which patients had local recurrences and returned regularly at stated intervals for examination 75 per cent are alive and free from symptoms referable to the bladder and have been for 5 or more years.

VIRGIL S. COUNSELLER

MASTER SURGEONS OF AMERICA

CHARLES BEYLARD GUERARD DE NANCRÈDE

On December 30 1847 Charles Beylard Guerard de Nancrède, was born at Philadelphia, Pennsylvania the son of Thomas Dixie Nancrède wholesale importer and May Elizabeth Nancrède nee Bull he died April 12 1921 at Ann Arbor Michigan.

Dr de Nancrède's paternal ancestors were of French Huguenot origin. His grandfather Paul Joseph de Nancrède was born in Hericy France, and came to the United States as a lieutenant in the French Army. He served under Rochambeau and was wounded at Yorktown. He emigrated with his wife to the United States in 1785 and became professor of French at Harvard where he taught for 10 years, from 1787 to 1797.

The early education of Dr de Nancrède was in private classical schools and in a military school at the latter he was honored by being selected as one of the cadets who fired the salute at Lincoln's funeral. He later entered the University of Pennsylvania and graduated from the medical department with the degree of doctor of medicine in 1869. Although primarily a medical man and devoted to his work, he had a fondness for art and music. He was particularly interested in painting and once said "I would have made a better painter in the Fine arts than a surgeon."

His work in physiology anatomy and in the eye service at the University of Pennsylvania helped to broaden his medical knowledge. He had considerable training in surgery of the eye and did some major eye surgery where speed was essential, without the aid of an anæsthetic this training helped develop his exceptional lightness of touch and speed in surgical technique.

He was one of the first surgeons in Philadelphia to operate for bullet wounds of the stomach and intestine and later for appendicitis. One of the first operations for the removal of the appendix was done in Philadelphia at the Episcopal Hospital where he was an attending surgeon.

Later he became surgeon and clinical lecturer on rectal and general surgery in the Jefferson Hospital Medical College. He was also attending surgeon at St. Christopher's Hospital for Crippled Children and at the Philadelphia Poly clinic where later he was made emeritus professor of general and orthopedic surgery. He was one of the first surgeons to devote time and study to the diag-



CHARLES B G DE NANCREDE
1847-1921

nosis and treatment of brain abscess and cortical epilepsy. He was a persistent advocate of Listerism and, with Drs Keen and Mears has been more than once accredited before the Academy of Surgery as chiefly responsible for establishing this practice in Philadelphia.

At the time of his coming to Ann Arbor the antiseptic era of surgery had begun. Throughout his early days at Ann Arbor he fought not only for antiseptic surgery but for aseptic surgery as well. We who knew him as students will always remember the emphasis he placed on the necessity of practicing aseptic surgery. In addressing the medical students when he came to Ann Arbor as professor of surgery it is reported that he said "Gentlemen we will continue to operate on patients in this hospital. There will probably be many deaths. Where there is a death, do not blame the walls, look elsewhere for the cause."

Prior to accepting the chair of surgery at the University of Michigan he had been striving to enlarge his experience in every branch of the healing art. His untiring interest in other branches of medicine was always impressed upon his students—"I am not a surgeon but a medical man who operates." His activities were not limited to Ann Arbor as he held the chair of surgery and of clinical surgery at Dartmouth Medical College from 1900 to 1913 where he gave his course during the summer.

The recognition shown him by his colleagues is indicated by the honors which came to him. He was president of the American Surgical Association and vice president twice, he was major and chief surgeon United States Volunteers, third division, Second Army Corps during the War with Spain and served in the Santiago campaign in Cuba with the Fifth Corps. He was made a brevet lieutenant colonel for services to the wounded under fire July 1, 1898 and later was commissioned as a major in the Medical Reserve Corps, United States Army but was not called to active duty in the World War. He was twice president of the Washtenaw County Medical Society, president of the Northern Tri State Medical Society, corresponding member of the Royal Academy of Medicine, Rome, Italy, member, recorder, and editor of the transactions of the Pathological Society of Philadelphia, member and secretary of the Philadelphia County Medical Society, member of the Pennsylvania State Medical Society, the Ohio State Medical Society, the Colorado State Medical Society, the American Medical Association, the American College of Surgeons, the Detroit Surgical Society, the International Society of Surgery, International Congress at Madrid, Spain, and of the Philadelphia Academy of Natural Science. Aside from the degrees of A.B. and M.D., the following honorary degrees were conferred upon him—M.A. University of Pennsylvania, M.D. and LL.D. Jefferson Medical School, and A.M. and LL.D., University of Michigan.

Dr de Nancrède was a contributor to the *International Cyclopedia of Surgery*, the *Cyclopedia of the Diseases of Children*, Burnett's *Cyclopedia of Diseases of the*

Nose and Throat Dennis *System of Surgery* Parks *System of Surgery* by American authors, the *American Textbook of Surgery* and Bryant and Buck's *American Practice of Surgery*. He was the author of *Essentials of Anatomy* and of *Principles of Surgery*. The last a unique work, contained such expressions as "*vis a tergo*" "*pabulum*" "*locus minoris resistentiae*". The ideas expressed in this book can be studied with great profit today. He published also numerous monographs and papers on anatomical pathological and surgical subjects. He carried out research on the nature of the gastric juice of the dog, the effect of blood letting on inflammation, the sterilization of catheters and the rate of absorption of catgut. The personal attention which he gave to his patients no doubt deprived him of sufficient leisure to make his contributions to medicine even more voluminous.

He never spared himself or others where the welfare of the patient was concerned. Night calls had no terrors for him if the welfare of the patient was concerned. He frequently visited the hospital at night rather than leave this responsibility to his capable assistants. He was in fact, an individualist.

He was practically ambidextrous and exceedingly deft in his light touch, almost dainty with his small delicate hands. He was very exacting of himself and his staff in the thoroughness of examination of the potential surgical patient by inspection palpation auscultation and all the other means available to achieve a diagnosis. Speed in surgical technique combined with thorough anatomical knowledge marked his generation of surgeons and he was an outstanding example.

On June 3, 1872, he was married to Alice Howard Dunnington of Baltimore Maryland. Nine children were born to them and at the time of his death he was survived by his wife and five children. He was an affectionate indulgent father and very much devoted to his home and family. He had no ambitions along social lines, possibly because he had himself achieved such prominence that he realized the futility of such ambitions.

He was punctilious in his personal appearance, always maintaining an erect military bearing. This latter personal characteristic was undoubtedly developed during his early training and subsequent military duty. Direct in his personal relations with men, he had a high sense of honor and ethics, and a tremendous personal courage. He scorned any chicanery or political maneuvers which tended to develop enemies and he was somewhat contemptuous toward those who failed to agree with his policies. He was opinionated and seemingly somewhat intolerant of the view of others who differed with him, yet he was kindness itself and extremely tolerant of his students and of the younger men on the staff. They respected his knowledge and were very fond of him personally.

The late Dr. Victor C. Vaughan wrote in *A Doctor's Memories* of Dr. de Nancrede: "I cannot overestimate the services rendered to the University by this man. Dr. Reuben Peterson at a meeting of the Washtenaw County Medical

Society, June 1921, paid a glowing tribute "to the valuable and distinguished services of the great surgeon Dr de Nancrède "

One need only mention his high rank as professor of surgery, clinical surgery and director of the surgical clinics at the University of Michigan from 1889 to 1917, to show that he was universally recognized. His interest in surgery and his devotion to his patients endeared him in the hearts of all who had the privilege of attending the University Medical School during his time. One could not help but be stimulated by his enthusiasm. His influence will long remain in the minds of his students and it may well be said that his life and work represent the true ideal fulfilled.

GROVER C. PENBERTHY

EARLY AMERICAN HOSPITALS

THE CHARITY HOSPITAL OF LOUISIANA

A. E. FOSSIER, M.D. NEW ORLEANS, LOUISIANA

(O)NE hundred and ninety nine years ago and approximately 18 years after the founding of the City of New Orleans by Bienville, the *Charity Hospital of Louisiana* was founded. It is the oldest institution of its kind in the United States.

The sailor Jean Louis a resident of New Orleans, died at noon on the 21st day of January 1736. He left a holographic will in which the following was specified:

My debts having been paid and the above provisions having been executed, a sale shall be made of all that remains, which, I bequeath to serve in perpetuity to the founding of a *Hôpital for the Sick of the City of New Orleans*, without any one being able to change my purpose, and to secure the things necessary to succor the sick.

A site was immediately chosen at the extremity of the town which Governor Miros stated stood upon a portion of the ground allotted to the City's fortification and today corresponds to the square bounded by Rampart Basin, St. Peter and Toulouse Streets. The house of Madame de Kolly which formerly was a convent, was bought by Bienville and Salmon. Half of the money of the legacy was expended for beds and the usual hospital equipment, and with the remaining 5,000 livres, a large brick hall was built.

The only description of that hospital handed down to us today is to be had from the building contract which specified:

Sieur Du Breuil promises, obligates, and binds himself to build, construct and erect on the site of the said hospital a hall measuring forty feet in length by twenty five in breadth, and fourteen in height, including the foundations, the whole in walls of well conditioned bricks, subject to the supervision to plan and payment made, which he promises to construct for the price and sum of two hundred livres per cubic fathom, full or empty and the other requisites, such as lumber planks, coverings, iron work, and entire building at the same price as those furnished to His Majesty in this country. The said work was to begin immediately for which he was to be paid on account the sum of three thousand livres in specie.

This contract was signed on the 10th day of June, 1736.

The date of the completion of that building is unknown today but it can be logically stated that

its doors were thrown open to the sick poor some time in the fall of 1736. We are told that on March 20, 1737 the hospital had five patients.

For over forty years this *Hôpital des Pauvres* was a haven of hope for and administered to the suffering of those intrepid adventurers who, drawn by the lure of a promised El Dorado and the fallacious inducements held out by the wily John Law braved privations, hardships, and the pestilences of a primeval country and became stranded on our shores.

The devastating hurricane which played havoc with the city in the summer of the year 1779 converted the Jean Louis Hospital into a heap of ruins only the kitchen and the storehouse escaped the fury of the storm. The destruction of that hospital resulted in so much consternation and suffering that in speaking of that calamity Governor Don Estavon Miros said "Many sick paupers are now wandering throughout the city in quest of shelter and succor and are hourly exposed to perish upon the very streets, or in some obscure corner.

Nothing today is known about the medical management of the Jean Louis Hospital. Apparently the professional men of that time played more than a small part in the administration of the charity of that institution. The names of the physicians who administered to those diseased unfortunates during those forty years of its existence are lost to us. There is no record that has escaped the ravages of time and no historian has perpetuated the memory of those altruistic workers in behalf of suffering humanity.

Don Andreas de Almonaster y Roxas, a peccunious old gentleman who previously had been a war clerk and a civil notary impelled by the suffering and destitution of the colonists, generously offered not only to rebuild the hospital at his own expense, but to appropriate a yearly sum for its support. He offered the magnificent amount of \$114,000.00.

In the year 1782 King Charles III of Spain gave his consent to the rebuilding of this hospital. In that same year on the same site, and with the



Charity Hospital—1815-1832

salvaged material of the destroyed hospital a commodious substantial brick edifice rose from the ruins of the original Hospital of Jean Louis. In October 1786 the rebuilt hospital then called the San Carlos (St Charles) was dedicated. The following account of that historical occasion is taken from a letter, dated January 17 1794 by Almonaster addressed to the Governor Baron de Carondelet. It reads

In October of the year 1786 when the first Mass was said and the sick were received, I was put in possession of the patronage. In conformation to the cited laws, by a solemn act, in the presence of the most distinguished persons of the City the Lord Governor Don Estaban Miro your predecessor and the vicar curate Ecclesiastical Judge Fray Antonio de Sedella, the above named gentlemen bestowed upon me in the name of the King the keys of the said Hospital which he transferred to me by the same act, so that its care may be confined to my zeal and charity

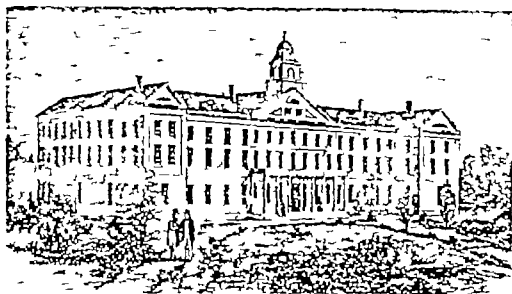
The first house physicians and surgeons of the Saint Charles hospital were Dr Don Santiago Leduc, who was appointed to the position in 1792, and Dr Don Louis Giobellina in 1794.

From an inventory made of the hospital in 1794 we learn that it had 35 small cypress bedsteads, 51 moss mattresses, 30 small linen pillows, 23 large cross-barred muslin mosquito bars, 10 small mosquito bars made of linen, 60 new sheets, 35 white woolen blankets etc. And an interesting part of this document records as the property of the hospital the following slaves. "One negro carpenter named Petro aged fifty five years, one negro carpenter named Joseph thirty five years, another Phillip sixty years old, one little negro boy named Andres of fourteen years, another

little negro boy named Francisco of two and one-half years, one negro girl named Maria, aged eleven and five lots of ground situated in the city.

This inventory not only gives us today a glimpse of the management of the hospital but reveals many interesting facts. Of special interest to us today is the Chapel. It appears that a large amount of the endowment was expended in its lavish furnishings, which were in striking contrast to the scant equipment for the use of the sick. Drugs were not listed in this document. Remedies must have been procured from the apothecaries. (There were five drug stores at that time in the city). No mention is made of surgical instruments or implements. Without doubt surgery was practiced in that institution. It must be presumed that the operations were performed in the wards on patients in their beds with instruments belonging to the attending physicians.

The census for the year 1796 gave New Orleans 9 756 inhabitants. The Saint Charles was a 24 bed hospital. Its size and capacity in relation to the then population was of more favorable comparison than the hospital of the present day. A concept of the good accomplished, the charity performed, the suffering alleviated, and the number of the sick cared for by that institution can be had only by referring to the vital statistics and the few remaining documents of that time. The extreme suffering, exposure, and the frequent pestilences to which these colonists were continually exposed, and from which only the hardi-



Charity Hospital—1832

est could escape confirmed the extremely high death rate then current. The total mortality in New Orleans in 1796 was 638, one death to every 13.57 inhabitants, making a ratio of 72.86 per thousand population.

From its foundation the hospital had derived a portion of its income from the legacies of devout and charitable persons. From the earliest time it has been the custom of the French to mention the hospital in their wills. There are scores of testaments extant in which the Charity Hospital is the beneficiary.

Don Almonaster died on the 26th of April, 1798 and he was interred in the Saint Louis Cathedral in New Orleans where his remains still repose.

The San Carlos Hospital and many other public buildings were reduced to ashes by the great conflagration which swept the city on the historical night of the 23rd of September of the year 1809.

A second time the destruction of the hospital resulted in intense suffering and hardship to the indigent sick. The rescued patients were quartered by the Mayor of the City, James Mather for but a day in the upper gallery of the Cabildo the then City Hall. Temporary quarters were then provided for the patients on the Jourdan plantation on the site of the present Industrial Canal. This most undesirable location was abandoned after six months of suffering and discomfort to the patients. For five years the Charity Hospital did not have a suitable house for the care of the sick, and it was not until the year 1814 that the square bounded by Canal Common

Phillips (now University Place) and Baronne, the present site of the Roosevelt Hotel was sold by the City to the Administrators of the Charity Hospital. The new hospital was ordered constructed by the Legislature of the State of Louisiana in a bill promulgated April 25, 1811. The corner stone of the edifice was laid in 1815.

The following description of this hospital is taken from the city directory for the year 1823:

The Charity Hospital, situated N. 147 Canal Street, consists of two large buildings, containing one surgical hall, two large fever wards, one dysentery ward, one ward for chronic cases, one for females, one for convalescents, one building room, one apothecary store and a number of other apartments for the families of the residents, officers, etc. The Hospital has lately undergone a complete repair and reform, and is at this time as clean, wholesome, and well conducted as any institution of the kind in the Union. During the last year about 700 sick persons were admitted, 1200 of whom were discharged well, and the remainder died, one-half of which, of Yellow Fever. The lot on which these buildings stand embraces the whole square between Canal, Common, Baronne and Phillips streets, and is laid off as a garden and poultry yard, etc. About 1200 males and females were admitted during the year '82, and as many as 120 persons received attention at one time.

It was a 120 bed hospital. This institution in its equipment and management was second to no other in this country. There were bathing facilities, an apothecary and the fever cases were segregated from surgical cases.

In 1820, an Act of the Legislature provided for the erection of a separate building "to receive and attend such persons as may have fallen into a state of insanity."

Because the rapidly growing population of the city and the extraordinary number of destitute sick from every state of the Union and from every country of the world demanded a larger and more commodious institution, the State Legislature in 1830, authorized the selling of the hospital building on Canal street. In 1832 it was sold to the State for \$125,000.00. The main building was then converted into the Capitol of the State of Louisiana. Years afterward the Common street side of the square became the site of the Medical College of Louisiana, now Tulane University.

The present site of the Charity Hospital was selected in 1832. The cost of construction and of the grounds amounted to approximately \$150,000.00. The magnificent edifice, the main building of the splendid group of buildings which today comprises the Charity Hospital of Louisiana, and which has reached its centenary, stands today practically the same as on the first day it opened its doors and inaugurated its long service to suffering humanity. Even now it stands as a model of hospital architecture for this climate: its high ceilings, its long and wide halls, its numerous large outside openings and its spacious verandas give it sufficient ventilation, make it cool in summer and at all times cheerful. These are features of construction not usually found in modern institutions.

The following description of the so called New Charity Hospital was published in New Orleans in 1840:

The building was of great size, being about 300 feet in its total length, and three stories high. It is composed of a corps of loges opening into a spacious hall, intersected at right angles by another running lengthwise of the building on which the wards open. From this hall access is had by broad stairs to the upper stories which are similarly divided, and thus to the cupola from which there is a magnificent view of the city and environs. The lower story is occupied by the Library, Physicians' Room, Surgeons' Room, etc. and the second and third stories into wards for the patients, twenty-one in number, as also into four other apartments designed as such. It is calculated to hold 540 patients.

The second floor was appropriated to the use of female patients and was divided as follows: A ward for women of good character, another for those of bad, and also one for the exclusive use of surgical and obstetrical cases. The grounds around it were enclosed with a substantial brick wall, and were handsomely improved and neatly kept.

The portals of this edifice were thrown open to the destitute sick on October 8, 1832.

The Sisters of Charity inaugurated their long period of admirable devotion to the sick and afflicted on January 6, 1834. For over a century they have given uninterrupted altruistic services to the Charity Hospital. Too much cannot be

said in praise of these pious religious, who spurning all mundane glory, dedicated their lives to unrelenting toil for the alleviation of suffering, and who have braved pestilences and epidemics and even risked existence itself for the devoted love of humanity. The services of the Sisters of Charity are indispensable to the Charity Hospital and their value cannot be appraised merely in monetary terms. The respect they command is an incentive to a greater discipline and a stimulus to more energetic work from their subordinates. In actual work, in enforcing economy in preventing waste, their services have been invaluable and their scrupulous management of the domestic and nursing departments has been the leading constituent in the success of the institution through a century of uncertain revenues and inadequate appropriations.

In the past hundred years the growth of the Charity Hospital was rapid. In the 1840's its yearly total number of admissions was from eleven to sixteen thousand patients. It was then one of the largest if not the largest hospital in existence.

Today the Charity Hospital has a capacity of 1,765 beds. The total number of indoor patients for 1931 was 47,182, with a daily average of 2,102. Its outdoor clinics numbered 318,735 consultations. Its records for that year give 26,124 operations including those performed on the eye, ear, nose and throat, and 2,566 obstetrical cases.

A magnificent seven story edifice with a capacity of 250 beds for the convalescents has been constructed.

More than one-third of the deaths registered in New Orleans occur in that institution. Approximately only one half of the total number of indoor patients are residents of New Orleans; the remainder is composed of individuals from every parish of Louisiana and from every neighboring state. Naturally this unusual condition results in an excessively large non resident mortality in that city and a corresponding inflation of its death rate. This condition is unique among the large medical centers of this country.

For 100 years this institution has been the cradle of medical education in the South.

From an historical standpoint as well as from the unlimited scope of its charity it stands unique among the great hospitals of the world. It was founded nearly two hundred years ago during the time of the French domination. It was rebuilt with the sanction of the King of Spain, when Louisiana was a Spanish possession. In the early period of the nineteenth century, its history emblazons in immortal pages an epic of

the greatest distress and suffering ever experienced by man. During the trying days of the Civil War it was converted into a military hospital for the care of the Union soldiers.

In the beginning of the past century when New Orleans was in the making when it was a city to which unknown thousands of young pioneers, the flower of manhood from every state of the Union and from every country of the world, flocked in quest of wealth or of refuge from political despotism and religious persecution, unfortunately too

often to have their hopes and ambitions shattered, to become a prey to the ever recurrent epidemics or to prematurely fill a wet grave the Charity Hospital was their only haven in their dire hours of suffering and despair.

Then it was not the Charity Hospital of Louisiana, but the Charity Hospital of the World. Well may it be said of this institution:

The deeds of charity we have done stay with us forever. Only the wealth we so bestowed do we keep. The other is not ours.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE little book by Clapp on cataract is a timely and useful one, since there had not appeared in English any summary of the recent important advances in our knowledge of the crystalline lens comparable to the book of Siegrist or chapters of Jesse and Hess in the larger German handbooks.

The chapters contributed by Ida Mann on the embryology and comparative anatomy of the lens are excellent for the amount of space given them and are especially important for the study of this fascinating organ whose entire history from the closing of the lens vesicle to adult life is now made visible to the clinician by the slit lamp and corneal microscope. Knowledge of this history allows proper interpretation of the various forms of congenital lens opacity and their distinction from acquired or senile opacities which are progressive. The more important of these congenital forms are described and illustrated, in some instances by good original drawings from the Wilmer Institute. In most cases, illustrations have been carefully selected from the previous literature.

A chapter on the chemistry of the normal and pathological lens shows a thorough knowledge of recent important work, including the demonstration of true oxygen metabolism in the avascular lens and of the presence of glutathione as the important hydrogen donor in this process. This substance is absent in the completely cataractous lens, and this fact is possibly of importance in the genesis of cataract. In spite of the great amount of chemical investigation and a knowledge of the etiology of certain types of cataract such as that after removal of the parathyroids no generally accepted theory as to the etiology of senile cataract has been formulated. The author's own investigation of the growth of the lens and its increase in weight from the seventh to the one hundred and fiftieth day is interesting.

In discussing the various types of acquired cataract and their treatment the author includes a great number of references to the literature, but at times has apparently not fully digested this work, since work of little importance is given equal space with that of real value. Thus it was hardly necessary to mention the injection of nitrogen into the anterior chamber to prevent traumatic cataract, a procedure purely experimental and clinically untried while the brief assembly of positive and negative evidence as to the occurrence of cataract in leprosy

leaves us practically where we started. The classification of senile cataract is not very clear since surely peripheral cataracts and cortical opacities are one and the same, while morgagnian cataract is definitely a subdivision of hypermature cataract.

The non-surgical treatment of cataract is discussed, as it should be, without enthusiasm though perhaps the author's negative conclusions might be even more strongly stated.

The discussion of the various types of cataract operation, anesthesia, paralysis of the lids before operation (akinesia) and after-care, is excellent. In discussing Verhoeff's method of intracapsular extraction no mention is made of an important change in his technique by which the lens capsule is grasped at the upper equator instead of below. In Sinclair's method, the important fact that his capsule forceps are made with a cross-action handle and hence retain their hold on the capsule automatically is omitted. It seems to the reviewer that among the methods of operating for glaucoma following cataract extraction, cyclo-dialysis, which is employed as the operation of choice by Elschnig and others for this condition, should have been included.

The discussion of the complications of the cataract and their treatment is quite complete. It is only natural that the theory of anaphylactic reaction to lens protein as an explanation of reactions following retention of cortex should be accepted by the author on account of the work of his associates, although many authorities differ with him on this point. The full bibliographies offer an excellent opportunity to those interested in further study of particular questions which arise, altogether the book is well adapted to stimulate such study.

SAMFORD R. GIFFORD

THE appearance of the second edition of *Practical Obstetrics* by Bland and Montgomery within 2 years is proof of the popularity of the first edition. The present edition is an improvement over its predecessor but a few points of difference may be noted between the authors and the reviewer. In the differential diagnosis between simple vomiting of pregnancy and pernicious vomiting, the authors say (p. 159) that the "neurotic element (is) lacking in the latter. This statement is at variance with the opinion of many obstetricians. In the discussion of

¹ CATARACT, ITS ETIOLOGY AND TREATMENT. By Clyde A. Clapp, M.D. F.A.C.S. Philadelphia: Lea & Febiger 1934.

PRACTICAL OBSTETRICS FOR STUDENTS AND PRACTITIONERS. By F. Brooks Bland, M.D., and Thaddeus L. Montgomery, M.D. 2d ed. Philadelphia: F. A. Davis Co. 1934.

pages and 400 illustrations. The work is replete with case reports illustrated by slides, photographs, and roentgenograms. The remainder of the text is concerned with pathogenesis, microscopic and roentgen findings, rather than clinical diagnosis and prognosis. Practically nothing is given on clinical treatment except in case reports.

Malformations, fractures, and inflammation of the jaws are treated adequately and endocrine and

nutritional disturbances are each given a chapter. At least two-thirds of the book is allotted to cysts and tumors which are discussed exhaustively and very lucidly. The thoroughness of preparation is suggested in the unnecessarily complete bibliography which is appended to each chapter.

This book is scarcely styled for a textbook but as a reference work it will be a distinct addition to the literature of the subject. CHARLES W. FREEDMAN

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

COLLECTION DES INITIATIVES MEDICALES. Published under the direction of Dr. A. Sézary. Propédeutique Obstétricale. By L. Devraigne. Paris: Masson et Cie, 1934.

COLLECTION DES INITIATIVES MEDICALES. Published under the direction of Dr. A. Sézary. La Pratique Obstétricale. By L. Devraigne. Paris: Masson et Cie, 1935.

TRANSACTIONS OF THE PACIFIC COAST SOCIETY OF OBSTETRICS AND GYNECOLOGY. Volumes 1, 2, and 3. For the years 1931, 1932, and 1933. Edited by Albert Mathew, M.D. Portland, Oregon: The Western Journal of Surgery, 1934.

THE CARE OF THE AGED THE DYING AND THE DEAD. By Alfred Worcester, M.D., Sc.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1935.

SURGICAL DISEASES OF THE CHEST. By E. A. S. Ambrose Graham, A.B., M.D., F.A.C.S.; Jacob Jesse Singer, M.D., F.A.C.P.; and Harry C. Ballou, M.D., C.M., F.A.C.S. Philadelphia: Lea & Febiger, 1935.

BLOOD GROUPS AND BLOOD TRANSFUSION. By Alexander S. Wiener, A.B., M.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1935.

PARITY-CONTROL: DILEMA OR ACCIDENT? A MANUAL OF BIRTH-CONTROL. By Michael Fielding, M.D. Preface by H. G. Wells. New York: The Vanguard Press, 1935.

THE CYCLOPEDIA OF MEDICINE. Edited by George Morris Pierce, B.S., M.D., assisted by Edward L. Boria, A.B., M.D. Index to Vols. 1, 2, 3. Philadelphia: F. A. Davis Co., 1934.

THE NERVOUS PATIENT: A FRONTIER OF INTERNAL MEDICINE. By Charles Phillips Emerson, M.D. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1935.

THE ROMANCE OF EXPLORATION AND EMERGENCY FIRST AID FROM STAMPEL TO BYRD. New York: Burroughs Wellcome & Co., 1934.

THE GLASGOW ROYAL MATERNITY AND WOMEN'S HOSPITAL. Medical Report for the Year 1933. Prepared by D. McK. Hart, M.B., Ch.B., F.R.F.P.S.G., M.C.O.G. Glasgow: Aird & Coghill, Ltd., 1934.

HIGH OWEN THOMAS, A PERINATAL STUDY. By Frederick Watson. London: Oxford University Press, 1934.

A MANUAL OF OBSTETRICAL AND GYNECOLOGICAL PATHOLOGY. By John H. Teasdale, M.D. Edited by Abner J. Marshall, M.B. London: Oxford University Press, 1935.

ANESTHESIA AND ANALGESIA IN LABOR. By Katharine G. Lloyd-Williams, M.D., B.S. (Lond.). With a Foreword by Dame Louise McIlroy, D.B.E., D.Sc., M.D. (Glasg.), D.Sc. (Lond.), D.Sc., M.R.C.P., F.C.O.G. Baltimore: William Wood & Co., 1934.

HODDER'S SURGICAL MONOGRAPHS: CORRECTIVE RECONSTRUCTIVE SURGERY. By Joseph Safian, M.D. New York: Paul B. Hoeber Inc., 1935.

OBSTETRIC AND CARBON DIOXIDE THERAPY. By Argyll Campbell, M.D., D.Sc. (Edin.) and E. P. Poulton, M.A., D.M. (Oxon.), F.R.C.P. (Lond.). Foreword by Sir Leonard Hill, F.R.S. London: Oxford University Press, 1934.

THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY. Volume 8—Therapeutics. New York and London: D. Appleton-Century Co., 1935.

BIOLOGÍA Y PATOLOGÍA DE LA MUJER. TRATADO DE OBSTETRICIA Y GINECOLOGÍA, PUBLICADO BAJO LA DIRECCIÓN DE LOS DOCTORES JOSEF HALLER y LEONARD SEITZ. Traducido directamente del original alemán por Joaquín Gómez Grimaldo, con la colaboración técnica del Dr. D. Arcadio Sánchez López. Tomo 3. Madrid: Editorial Plus Ultra, 1935.

PHTHYSIOLOGIE UND PATHOLOGIE DER WEIBLICHEN ERGENISSE DER WEIBENSTUNDE. By Dr. Tamara Antine Venzel. Wilhelm Maudrich, 1935.

NAMES OF SURGICAL OPERATIONS: COMPILED AND ARRANGED BY THE BRITISH SURGICAL ASSOCIATION THROUGH ITS SPECIAL COMMITTEE. Edited by Carl E. Black, A.M., M.D. St. Paul: Minn. Bruce Publishing Co., 1935.

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HYPERPARATHYROIDISM

CLINICAL DIAGNOSIS AND THE OPERATIVE TECHNIQUE OF PARATHYROIDECTOMY

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THE clinical syndrome—hyperparathyroidism—due to excessive parathyroid secretion as occurs with adenoma of the parathyroid gland is now a well established entity. Rapid and pronounced relief of symptoms follows removal of the parathyroid adenoma. The differential diagnosis, however, is often confusing so that a true case of hyperparathyroidism may be missed or may even be unsuspected. The location and removal of the adenoma may present serious technical difficulties as evidenced by reports in the literature of cases operated upon several times in an attempt to find the adenoma.

In this paper five new proved cases of hyperparathyroidism are briefly reported and the significant findings which led to the diagnosis are discussed. The operative exposure for removal of a parathyroid adenoma is illustrated with particular emphasis upon the possible atypical location of parathyroid bodies—and so these tumors.

A consideration of the historical background of hyperparathyroidism is not included in this paper. (For references in this connection see bibliography.) It is however of interest to note a recent report by J. Bauer on further developments in the patient upon whom F. Mandl in 1926 performed the first operation to remove an adenoma of the parathyroid for relief of osteitis fibrosa cystica. Bauer reports as in the original articles by Mandl

that the initial result was good and a formerly bedridden patient was able to walk without pain at the end of 2 months. This improvement lasted for 6 years. In 1932, however, this patient was admitted to Bauer's clinic because of a return of the original symptoms of pain on movement of the extremities and because of progressive deformity of the skeleton. During hospitalization the patient developed renal colic caused by calculi. There was a hypercalcaemia (blood calcium 12.5 milligrams per hundred cubic centimeters) while the phosphorus was low (2.5 milligrams per hundred cubic centimeters). There was a negative calcium balance due to excretion of a large amount of calcium in the urine. A second operation was undertaken by Mandl because there appeared to be a return of the state of hyperparathyroidism. No tumor, however, was found. A subtotal thyroidectomy was therefore done. In this tissue Professor Sternberg found one normal parathyroid on the surface of and another within the body of the thyroid gland. There was no improvement following the operation. Bauer felt that symptoms persisted because of a hyperfunctioning adenoma of the parathyroid which because of inaccessible location was not found.

In view of the experience just related, as well as from a perusal of other cases reported in the literature together with our own experience

rience it is obvious that pronounced technical difficulties are frequently encountered in attempts to locate and remove adenomata of the parathyroid gland

Paget's disease of bones and parathyroid tumor In view of this recent report on the further progress of Mandl's case Kienbock states that a consideration of the entire course of this patient convinces him that the original diagnosis of Recklinghausen's osteitis fibrosa was erroneous. He believes this patient to be a case of Paget's disease of the bones associated with the unusual complication of a parathyroid tumor with the bone changes as described which in turn are rarely observed in Paget's osteitis. Emphasis is placed upon the absence of large cysts as seen in Recklinghausen's disease. Kienbock believes that the occurrence of the parathyroid adenoma in this instance was a coincidence rather than a cause of the condition. He further states that the mild form of hyperparathyroidism as suggested by the studies of the blood chemistry in Mandl's case is not infrequently seen in the porotic form of Paget's disease. Kienbock feels, however, that the two conditions, hyperparathyroidism and Paget's osteitis, are definitely distinct clinical entities. This conclusion is also stressed by W. Bauer. The authors in 5 cases of Paget's disease, have at no time found reason to suspect the presence of a parathyroid adenoma because the clinical data are not similar to that found in hyperparathyroidism. X-rays do not reveal a generalized skeletal involvement. Clinically Paget's disease of the bone is a different picture from that presented by hyperparathyroidism.

Chronic rheumatoid arthritis and hyperparathyroidism It has been suggested that hyperparathyroidism is an etiological factor in the ankylosing type of chronic arthritis. One of us (GEH) reviewed the findings in 200 carefully studied cases of chronic rheumatoid arthritis. In no instance was the diagnosis of hyperparathyroidism confirmed. For example, the blood serum calcium and phosphorus estimations were consistently within normal range while roentgenograms of the skeleton did not reveal the characteristic X-ray findings as described below.

DIAGNOSIS

The diagnosis of the clinical entity hyperparathyroidism depends primarily upon (1) an analysis of the chemical findings and (2) a careful survey of the roentgenograms, including not only those of the bones of the skeleton (especially plates of the skull spine, pelvis and femora) but also X-rays of the kidneys. The latter plates are taken to demonstrate the presence or absence of calculi. In very early cases of hyperparathyroidism or in the presence of severe renal damage study of the chemistry and X-ray findings may be misleading and the diagnosis not arrived at.

From the clinical standpoint cases of hyperparathyroidism may be conveniently classified in one of the following three groups:

1. Classical—the osteitis fibrosa cystica of von Recklinghausen's. Skeletal roentgenograms of these patients are quite characteristic, showing not only the diffuse granular osteoporosis but also the presence of multiple cysts.

2. Hyperparathyroidism with osteoporosis—these cases are an early stage of group one and rarely show cyst formation. The decalcification of the bone is not as advanced as in group one but there is present the characteristic osteoporosis, although at an early stage, as described below.

3. Cases in which renal pathology due to the precipitation of calcium phosphate, is the significant finding. In these patients X-rays of the skeleton are often negative. Albright, Baird, Cope, and Bloomberg have subdivided this group of cases as follows:

- a. Calculi in the renal pelvis, with resulting pyelonephritis. In a review of 38 cases there were 27 per cent in this group.

- b. Calculi in the renal tubules, with resulting renal sclerosis, contraction and insufficiency (23 per cent).

- c. Precipitation of calcium phosphate in the kidney as one of several organs with acute renal failure and death of undetermined cause in a few hours or days (1 per cent).

It is important to realize that renal lesions may occur without evidence of changes in the skeleton. The former are an index of the severity of the disease and the latter an index to its duration.

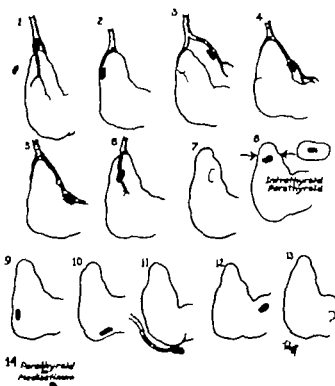


Fig. 1 On these diagrammatic illustrations of the anterior aspect of the thyroid we have recorded the locations at which we have encountered parathyroids in the course of several thousand thyroid operations and the points where we have discovered bodies suspected and proved in 190 cases by microscopic section to be parathyroid bodies. These are the cases in which we have searched thyroid specimens while still sterile, in which we have found and transplanted microscopically proved parathyroids. Of all these locations, that representing the superior parathyroid by dotted lines in 7 as being on the back of the upper pole where it rests against the larynx has been the most constant. The intrathyroid parathyroid as shown by barred lines in 8 is the location at which we have found parathyroid adenomata twice. Note in 7 a parathyroid shown in dotted lines on the posterior aspect of the thyroid resting against the trachea at the point where the isthmus and body join. Note in 14 the mediastinal location of a parathyroid and in 9, 10 and 12 parathyroids on the anterior aspect of the gland.

CLINICAL ASPECTS OF HYPERPARATHYROIDISM

The majority of the reported cases have occurred in females between 30 and 50 years of age. From an analysis of 115 proved cases (as detailed in the literature) Gutman, Swenson and Parsons state that pain in the back or extremities was the major initial symptom in 72 per cent, while 22 per cent primarily complained of muscle weakness. The possibility of hyperparathyroidism must always be considered in patients who complain of relatively diffuse 'neuritic' or 'arthritic' pains made worse by motion. This is particularly

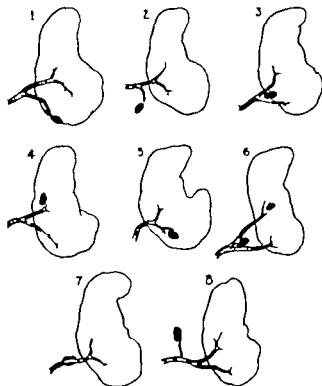


Fig. 2 These diagrammatic illustrations represent the thyroid gland pulled inward and exposing its entire posterior aspect as shown in the surgical illustrations Figures 9, 14, 19, 26, to 30 demonstrating the location of parathyroid adenomata at operation. On these are placed the locations at which inferior parathyroids have been demonstrated at thyroid operations and found and proved by microscopic section on the 190 parathyroid specimens removed and proved at the operating table. The most constant locations of parathyroid glands have been as shown in 3, 4, 5 and 6.

true if the symptoms exhibit localized or general bone tenderness and if there is a history of pathological fracture. Not infrequently patients will report a progressive loss in stature (see Case 4).

The majority of the cases in the literature were reported to be in negative calcium balance. That is these patients required a larger amount of calcium than the amount ordinarily believed to be adequate for maintenance of the normal individual in equilibrium. In early states of the disease a negative balance may not be present while in patients with bone involvement from multiple myeloma or metastatic carcinoma a definite negative calcium balance can often be demonstrated.

Classical hyperparathyroidism is characterized by an increased ratio of calcium in the urine to the total amount of calcium excreted



FIG 3



FIG 4



FIG 5

FIGS 3, 4, and 5. Case. Photographs of patient with hyperparathyroidism showing marked deformity of spine and thorax. Compare with Figures 7 and 8.

except in group 3 cases where the renal function is seriously impaired.

Blood chemistry. Classical hyperparathyroidism usually reveals an elevated blood calcium and relatively low phosphorus. The blood phosphatase activity is also increased. Taking the serum calcium value of 11.5

milligrams as a high normal Gutman reviewed 78 cases in which the determination was recorded and found a blood calcium above 12 milligrams in 59 cases, while serum inorganic phosphorus determinations below 2.5 milligrams were found in 26 of 52 cases.

Obviously hypercalcemia and hypophosphatemia are not consistently found in suspected cases. Particularly is this true in the presence of severe renal damage. Albright has shown that in these cases (group 3) the blood serum phosphorus rises, and the calcium tends to fall. Furthermore, Peters and Van Slyke have stressed the necessity of interpreting serum calcium values in view of the phosphorus and blood serum protein determinations.

In reviewing our knowledge of the blood phosphatase Kay states it to be an enzyme present in the calcifying cartilage and that its rise in hyperparathyroidism is a secondary effect. The source of the increased amount of blood phosphatase is not definitely known. Albright and his coworkers feel that this determination is an index of the degree of bone involvement, because in clinically proved cases of early parathyroid disease, without demonstrable bone change, the blood serum phosphatase is normal (normal being approximately three Bodansky units). Very high values have been found in active rickets (thirty to one hundred and sixty-five units) and in generalized Paget's osteitis (fifty to one hundred and thirty-five units). The same is



FIG 6. Case. Roentgenogram of skull showing thickening of calvarium with loss of clear demarcation between the inner and outer table. The diffuse osteoporosis is well shown.



Fig 7 Case 1 Anterior posterior roentgenogram of thorax illustrating deforming action of muscles of respiration on the softened bone



Fig 8 Case 1 Lateral roentgenogram of spine exhibiting pronounced crushing down of vertebral bodies with consequent loss in stature

true in the blood serum of patients with obstructive jaundice

X ray findings If the diagnosis of hyperparathyroidism is suspected X ray studies should include plates of the skull spine and pelvis. In addition to roentgenograms made of the extremities presenting symptoms plates of the femora and humeri are also helpful in detecting early bone change. The characteristic changes in the skeleton together with comparable pathological findings as described by Hoffmeiz are outlined as follows

Skull (Figs 24-27) There is a definite thickening of the calvarium together with a pronounced blurring of outline so that the demarcation between inner and outer tables is very poorly defined at times lost. The bones present a finely mottled granular appearance that is a diffuse osteoporosis. In the more advanced cases there are large irregular areas of diminished density and these are often more pronounced in the mandible and maxilla.

From observations at necropsy Hoffmeiz found the surface of the bones of the skull to be very rough with numerous irregularly spaced sharp pointed projections between which were depressions averaging 2 to 3 milli-

imeters in size. Also seen on the bone surface were scattered depressed areas 2 to 3 centimeters in diameter with adjacent osteophytic deposits. Most of the bone was sufficiently soft to be easily cut with a knife. The inner and outer tables could not be recognized on section.

In a chemical analysis of bone from a patient with hyperparathyroidism Wilder found considerable loss of calcium and phosphorus and a relative if not an absolute gain in organic matter.

Vertebrae The vertebral body of advanced cases shows a pronounced crushing or narrowing particularly at the anterior margin (Fig 8). In less severely affected vertebrae there is an increase in the convexity of the superior and inferior body surfaces. Such deformity affecting many vertebral segments results in a pronounced kyphosis thus causing a marked increase in the normal anterior posterior curve of the spine, as well as a loss in stature (Fig 8). The vertebral body in some instances presents a finely mottled appearance with coarse perpendicular striae. In other cases (Fig 29) there is a diffuse, rather even,

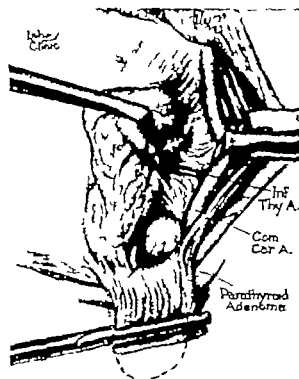


Fig 9. Case. In this drawing made by the artist at the operation, the top of the large intrathoracic parathyroid adenoma may be seen appearing just above the level of the clavicle and the size of the intrathoracic portion outlined by dashes upon the chest wall. The shadow of this intrathoracic parathyroid tumor is demonstrated in the accompanying X ray film of this patient's superior mediastinum. Note the high position of the inferior thyroid artery. We have called attention to the not infrequent high course of this vessel. The recurrent laryngeal nerve was safely located as it so often is in intrathoracic thyroid adenomata posterior to the intrathoracic parathyroid adenoma so that it was not injured.

decalcification of the entire bone. The intervertebral discs are not affected.

In connection with the spine Figure 7 well illustrates the deforming action of the muscles of respiration on the softened thoracic cage, a deformity analogous to that seen in severe rickets.

Pelvis. The pelvic bones exhibit changes similar to those seen in the skull. In many instances, the pelvis is markedly deformed, presenting a wedge-shaped appearance with large cystic areas scattered throughout the bone.

Bones of the extremities. Figure 12 shows the femora of Case 2 upon which X ray films the diagnosis of hyperparathyroidism

was made to be later confirmed by chemical analyses and operative findings. These plates are typical of the early bone change (type 1) and illustrate a slight but definite diffuse osteoporosis of the femora.

Compare the plates mentioned with those of Figure 18 which illustrates bone change in the femur of an advanced case of hyperparathyroidism of long duration. Here is seen evidence of old healed spontaneous fractures. The cortex of the bone is exceedingly thin. There is a pronounced generalized demineralization so marked indeed that the mottled appearance is not evident. Where cysts are found expansion of the cortex occurs. There is no periosteal proliferation.

The characteristic subperiosteal rarefaction of the cortex and the formation of small cysts are usually best shown at the metaphysis of the long bones and on the superior and inferior margins of the ribs.

The pathological studies of Hoffmann reveal that the bones of the extremities show much less evidence of alteration of structure than is the case in the bones of the skull. In the femora and humeri even in advanced cases, there is a clear differentiation between the cortex and the spongy bone.

Location of bone changes. The site of the bone lesions in hyperparathyroidism may be explained by the work of Jaffe, Bodansky and Blair through their investigations on guinea pigs, dogs, and rats. These animals were given large doses of parathormone with the resulting specific effect of decalcification of the bones. The resorption of bone was established by histological study which revealed the presence of large haversian canals and of lacunae containing osteoclasts on the periosteal and endosteal surfaces of bone.

The authors point out that bone resorption and bone deposition is a process that constantly goes on in all bone and that these processes are more rapid in the regions of active bone growth. If the rate of either resorption or deposition of bone is increased it is increased throughout the animal body. Hence, if a condition is present favoring an excess of resorption of bone, as hyperparathyroidism, such resorption will be most evident in the regions of active bone growth. A pronounced

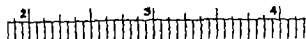


Fig 10 Case 1 Photograph of tumor removed

stimulus as hyperparathyroidism of long duration would be necessary to affect the whole skeleton

The above theory would then explain the pronounced susceptibility to resorption of the spongy bone of the metaphyses and of the cortical shaft in the epiphyseal regions in the rapidly growing long tubular bones as well as resorption at the costochondral junctions of the ribs the rib cortex and in the bones of the skull

Summary of X ray findings The bone changes in hyperparathyroidism as shown by roentgenograms may therefore be summarized as follows

1 In the relatively early cases there is a diffuse osteoporosis The bone exhibits a finely mottled granular appearance or there may be a pronounced general demineralization of the bone. In the more advanced cases there are large irregular areas of diminished density with cyst formation The cortex of the long tubular bones is exceedingly thin particularly in the epiphyseal regions. No periosteal reaction is seen

2 In long standing cases bone deformity is present viz a pronounced kyphosis of the spine due to crushing down at the anterior margin of many vertebral bodies, deformity of the ribs the result of action of muscles of respiration on the softened thoracic cage wedge-shaped pelvis and finally the de-

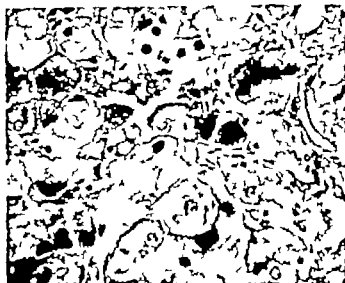


Fig 11 Case 1 Photomicrograph of parathyroid adenoma $\times 475$

formities following spontaneous fracture of the long bones.

With the diagnosis of hyperparathyroidism established the problem then relates itself for the most part to the question of finding the parathyroid adenoma and removing it. Albright Bauer and Churchill have recently reported cases of hyperparathyroidism apparently not due to adenomata of the parathyroids but rather to hyperplasia of all the parathyroids This finding as we have previously stated complicates the management of hyperparathyroidism and if proved by further experience with this condition to be convincingly true may explain some of the cases in which search for a parathyroid tumor has proved unsuccessful

Failure to find parathyroid adenomata in many cases will be due to failure to realize the frequent atypical location of the parathyroids and failure to investigate the possible atypical locations for a possible parathyroid adenoma

It becomes also the duty of pathologists in view of this report from a group of men who have done such sound work in connection with this disease to familiarize themselves with the normal and abnormal pathology of the parathyroid gland, since it will be necessary in cases in which adenomata cannot be found to call the pathologists into the operating room for opinions on frozen sections first as to whether removed specimens are, or

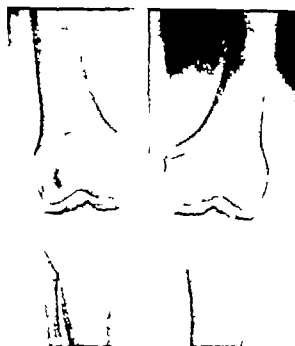


Fig. 12 Case 2. Note the slight but definite diffuse osteoporosis of these femora. (Type 2)



Fig. 13 Case 2. Anterior-posterior X-ray picture of cervical spine which show early even generalized demineralization of the bones to be compared with Figure 12. In this plate definite hypertrophic arthritic changes are also seen. The one patient in this series in which these findings were observed.

are not parathyroids and second whether or not parathyroid hyperplasia if adenomata are not found comparable with that in hyperthyroidism exists and whether or not on such evidence combined with the clinical findings subtotal parathyroidectomy is justified. With these ideas in mind our pathologists have undertaken a review of the histology of all of our fixed and preserved parathyroid specimens amounting to one hundred and ninety specimens, each representing a section of an individual parathyroid—their report to be published later.

As the result of the plan which we have published previously¹ of searching every thyroid specimen surgically removed for possible parathyroids and of reimplanting the removed parathyroid body into the left sternomastoid muscle, a large number of parathyroid glands have been found on the removed thyroid gland. Due also to the policy before transplantation of cutting off a small gross section of the suspected parathyroid gland and submitting it to the pathologist for

report we have acquired a relatively large mass of parathyroid material and a microscopically proved experience in deciding as to what is and what is not a parathyroid, with variation in shape, size, color and location of these glands.

The parathyroid most easy to distinguish has a brownish color varying from dark to light mahogany brown. It has molded edges, quite similar to the molded edges seen in a miniature lima bean. In fact one of us (FHL) has often stated that, except for the fact that they are small and tend to be convex on one side and concave on the side in contact with the thyroid the typical non adenomatous parathyroid more closely resembles a miniature lima bean (except as to color) than any thing else.

As the result of our experience now with over 13,000 thyroid operations in all of which the regions where parathyroids are found are widely exposed and when possible parathyroids demonstrated, we have learned that there is considerable variation in size in the non-adenomatous parathyroid glands from that of the head of a match up to the size of a small lima bean. We have likewise learned

Frank H. Labey: The translocation of parathyroids in partial thyroidectomy. *Surg. Gynec. & Obst.* 1930, 41: 266-269.

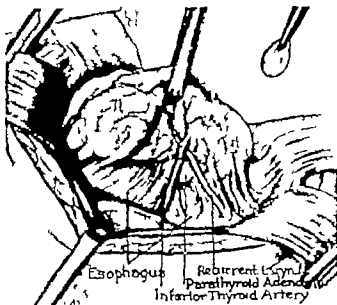


Fig. 14. Case 2. The parathyroid adenoma as shown in this illustration made at the time of operation was found in the groove between the trachea and esophagus behind the trunk of the inferior thyroid artery and beneath the recurrent laryngeal nerve. This is not an uncommon location for parathyroids. As may be seen in the diagrammatic illustrations, Figures 1 and 2 showing the points on the back of the thyroid gland where parathyroids have been found in thyroid operations, should an adenoma occur in the parathyroid shown in Figures 3, 6 or 7 it would be located in just the same position as was the one in this case. The tumor shown in the jaws of the hemostat is the actual size of the parathyroid adenoma on removal.

The course and relationship of the inferior thyroid artery and recurrent laryngeal nerve as shown here is the one which we most commonly see in our thyroid operations.

Note in all of these cases that the prethyroid muscles have been cut, the gland pulled inward with thyroid grasping forceps, and its posterior aspect widely exposed.

that the back of the thyroid gland (in contact with which gland the parathyroid glands commonly rest) is sometimes quite free from yellow fatty tissue so that brown parathyroids are readily located and distinguished while at other times this region is thickly sprinkled with fat particularly about the point where the branches of the inferior thyroid artery penetrate the gland and where inferior parathyroid glands are so often demonstrable thus making the demonstration of these bodies less certain.

Such parathyroids are sometimes overlaid by adipose tissue and are yellow or pale white in color. In such fat infiltrated parathyroids one of us (FHL) has noted the tendency of these glands to be more globular in shape and to have lost the molded edges characterizing the more typical more easily distinguished glands.



Fig. 15. Case 2. Photomicrograph of parathyroid tumor tissue $\times 140$.

Early in our experience with parathyroid bodies we had impressed upon us and remarked it in our publications on this subject that these glands were often atypically located and that they might be found anywhere—on in behind or below the thyroid gland. During one of his visits with us Dr. Wallace I. Terry became interested in our demonstration of atypically placed parathyroids and delegated one of his junior men, Dr. Raymond J. Millner, to search all specimens for such atypically located parathyroid glands with the result that valuable reports concerning such atypical locations have also emanated from Dr. Terry's clinic in San Francisco. Recently with the interest intensified in hyperparathyroidism reports are frequently appearing in this country and abroad concerning atypically located parathyroid bodies which have become the site of parathyroid adenomata.

The two most constant points at which we have found parathyroid bodies have been on the back of the gland close to the point at which the inferior thyroid artery enters the gland and below the lateral exit of the middle and lower thyroid veins (the inferior parathyroids), and on the posterior lateral aspect of the upper pole of the thyroid where it rests against the laryngeal cartilage (superior parathyroid).

We have seen microscopically proved parathyroid bodies atypically situated so often in



Fig 16

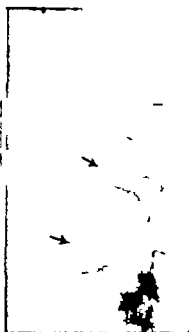


Fig 17



Fig 18

Fig 16 Case 3. Roentgenogram of lower spine and pelvis. A long standing case of hyperparathyroidism with consequent bone deformity. Compare with Figures 17, 18.

Fig 17 Case 3. Lateral X-ray film of lower spine illustrating marked crushing down of vertebral bodies with old healed fracture.

Fig 18 Case 3. Compare with Figure 17. Here are shown the bone changes in the femur of an advanced case of hyperparathyroidism of long duration. The old but now healed spontaneous fractures are evident. The cortex of the bone is exceedingly thin. Generalized demineralization is seen. There is no periosteal proliferation.

a variety of locations that it has seemed best to illustrate their possible location by placing them on diagrammatic outlines of the thyroid seen from an anterior (Figure 1) and posterior (Figure 2) view. We have seen parathyroids in the mediastinum (parathyroid adenomata and on intrathoracic goiters) on the side of the thyroid gland, on the front of the thyroid gland, in the bundle of vessels entering the upper pole, in the groove between the trachea and esophagus well away from the gland, out on the trunk of the inferior thyroid artery, before it had divided and within the substance of the thyroid gland itself. Dr. R. B. Cattell, working in the Clinic in 1924 on the relation of the histology of the thyroid to the administration of iodine (at which time sections were made of 400 hyperplastic thyroid glands removed at operation) first called our attention to the relative frequency with which intrathyroid parathyroids were found within the specimen removed by subtotal thyroidectomy.

As the result of a large experience (190) with the microscopically proved parathyroids at thyroid operations and on the specimen immediately after the operation with the specimen still sterile, we believe we can safely state that a parathyroid may be found at practically any position on in, behind, or below the thyroid gland.

The technique of demonstrating and removing parathyroid adenomata is related largely to exposure of the region where parathyroid bodies are found when typically located and a knowledge of the regions in which to search for them when parathyroid adenomata are not demonstrated in typical locations.

The first requirement of any operation for removal of a parathyroid adenoma is exposure. This involves in our hands an adequate thyroid incision with a severing of the prethyroid muscles high between clamps. Without these muscles severed we are not able to obtain wide exposure of the back of the gland from its lowest point up to its upper pole.

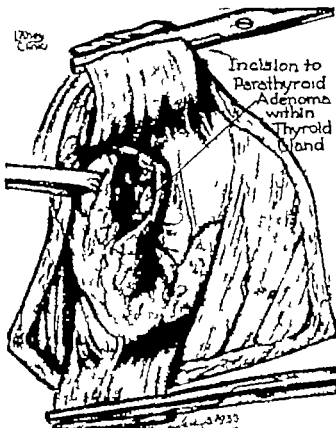


Fig. 19. Case 3. In this illustration made at the time of operation one sees the upper pole of the thyroid gland split where it rests against the larynx and an intrathyroid parathyroid demonstrated within the substance of the thyroid gland. By pressing the upper pole of the thyroid gland against the thyroid cartilage, this small tumor could be palpated as a bean-like structure within the gland, demonstrated removed and immediately proved by frozen section to be a parathyroid adenoma.

As stated in the text, in a case seen in consultation, see Figure 32 a and b, in which two previous unsuccessful searches for a parathyroid adenoma had been made, at our suggestion a careful search at the third operation for an intrathyroid parathyroid revealed one and permitted its removal. Where definite chemical, clinical, and X-ray evidence of hyperparathyroidism are present but the parathyroid tumor not evident on operative exposure, careful palpation of the thyroid gland must be made with the possibility that the parathyroid adenoma is within the gland.

In the diagrammatic drawing (Fig. 1) showing the locations of parathyroids from the front of the gland, this position is shown in 8. This should not be a very uncommon location for parathyroid adenomata since 7 shows in dotted lines the location in our experience of the most constantly placed superior parathyroid just behind the internal and lateral aspect of the upper pole where it rests against the thyroid cartilage.

With the muscles severed the middle thy thyroid veins are ligated between clamps so that the lateral vascular attachments of the thyroid to the internal jugular vein are severed. The outer border of the thyroid gland is then grasped with the thyroid grasping forceps

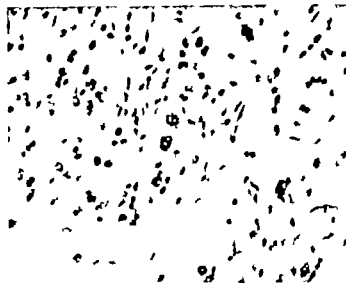


Fig. 20. Case 3. Photomicrograph of parathyroid adenoma from this patient X500

which we have described lifted up, and rotated inward. The internal jugular vein and common carotid artery are completely separated from the back of the thyroid gland and the inferior thyroid artery completely demonstrated as a trunk where it passes behind the common carotid artery. The back of the gland is inspected for a tumor body on the gland and if a tumor cannot be seen, it is palpated for such a tumor within the gland. An adenoma of a parathyroid usually converts that structure into a globular mass and changes its color to a pale white rather than the brownish color characterizing the typical normal parathyroid.

Parathyroids involved or uninvolved by adenomata are characterized by being so movable on the back of the thyroid that they are demonstrably not part of that gland. On removal they have a glistening covering entirely surrounding the removed structure with no area over which this shining covering is absent. This is of value in distinguishing a parathyroid adenoma from an extruded adenomatous thyroid area in that the latter structure is usually connected with the thyroid itself by an isthmus of thyroid tissue, the severing of which in its detachment from the thyroid leaves a cut surface of thyroid tissue—interrupting thus the smooth and complete glistening capsule which is to be found in both parathyroids and parathyroid adenomata.



Fig 21

Fig 21. Case 4. Photograph of patient illustrates the upper dorsal round back, with consequent loss of stature due to crushing down of vertebral bodies as illustrated in roentgenograms of the spine, see Figures 22 and 23.

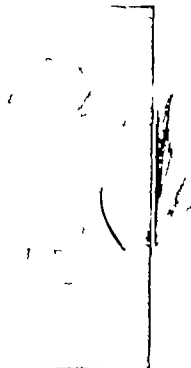


Fig 22



Fig 23

Figs 22 and 23. Case 4. Anteroposterior and lateral roentgenograms of spine. The body of the fifth dorsal vertebra is represented only by a thin wedge of bone. The patient stated there has been progressive loss in height.

Should no parathyroid adenoma be demonstrable on this exposure the inferior thyroid artery must be completely dissected up to its entrance into the thyroid gland. The recurrent laryngeal nerve must be found and dissected up to its passage behind or in front of the inferior thyroid artery. We have found and removed a parathyroid adenoma at this point behind the recurrent laryngeal nerve and inferior thyroid artery (Fig 14).

If still no parathyroid adenoma is found, one must expose the groove between the trachea and esophagus in the region of the inferior thyroid artery. If still the adenoma is undemonstrated the superior thyroid artery should be ligated and the upper pole of the thyroid turned downward so that the region where it rests against the thyroid cartilage may be inspected. In dissections at this point troublesome bleeding may arise from the ascending branch of the inferior thyroid artery a branch of which usually nourishes

the upper parathyroid. In controlling bleeding at this point caution must be exercised as the recurrent laryngeal nerve enters the larynx here, at the point where the lowest fibers of the inferior constriction are inserted into the horn of the thyroid cartilage shown at X in Figure 26.

In the event that the tumor is still not found one palpates the thyroid through and through between the thumb and the forefinger and any discrete globular nodule within the gland is exposed by an incision into the gland removed and submitted to the pathologist for immediate frozen section report as to a possible intrathyroid parathyroid. We have removed such an intrathyroid parathyroid as shown in Figure 19.

The X ray picture of the bones of another patient is shown in Figure 35 a and b demonstrating to what an extreme state decalcification can extend in hyperparathyroidism. This patient was seen in consultation with Dr



Fig. 24. Case 4. The generalized decalcification and soft mottled appearance of the skull is characteristic.



Fig. 25. Case 4. Roentgenogram of pelvis illustrating the multiple large cystic areas seen in these bones.

Robert C. Cochrane at the Boston City Hospital. She was a case of proved hyperparathyroidism and had previously had two normal parathyroids removed without relief of symptoms. We advised another operation and a search within the thyroid gland itself. Such a search revealed an intrathyroid parathyroid adenoma which was removed.

With failure still to demonstrate the parathyroid tumor, the search is continued in the bundles of the superior thyroid vessels out along the main trunk of the inferior thyroid artery, behind the oesophagus and along the inner aspect of the upper pole. The isthmus is palpated against the trachea (a parathyroid has been reported as having been found on the posterior aspect of the isthmus). If a pyramidal lobe is present it is exposed and palpated throughout its extent.

If the evidence of the existence of hyperthyroidism be certain by clinical and laboratory evidence, and still no parathyroid tumor has been found, and if digital palpation of the superior mediastinum demonstrates no palpable parathyroid tumor, the manubrium of the sternum may be removed to facilitate a visual search for a mediastinal parathyroid

adenoma since we have and Churchill likewise has demonstrated and removed a parathyroid adenoma from the superior mediastinum.

Should exposure of all these regions fail to demonstrate an adenoma of a parathyroid, it then becomes justifiable to remove and submit a normal appearing parathyroid to the pathologist for decision as to the possible pressure of hyperplasia of the parathyroids.

A brief abstract of the cases of hyperparathyroidism is submitted below together with X rays of the bones, illustrations of the location of the parathyroids drawn by the artist at the time of removal, the actual size of the adenoma of the parathyroid, a microscopic section of the tumor and follow up notes as to their postoperative course and changes in blood chemistry.

CASE REPORTS

CASE 1. Mrs. Rebecca B. aged 62 years, housewife, April 17, 1933. Patient came to the Clinic because of a progressive increasing deformity of the upper spine, a round back, and a loss of stature of some 5 years duration. The degree of this deformity is well illustrated in Figures 3, 4, and 5. There were likewise multiple diffuse generalized aches and pains.

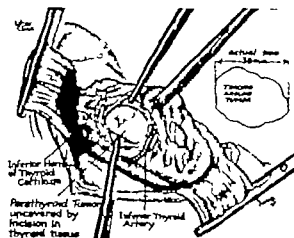


Fig. 26. Case 4. Is this illustration made at the time of operation, a tracing of the outline of the removed parathyroid adenoma is shown demonstrating thus the actual size of the tumor.

Note the location of this tumor just below the horn of the thyroid cartilage suggesting that this adenoma probably arose in the superior parathyroid where it so commonly rests against the thyroid cartilage.

This tumor was entirely covered by thyroid tissue but could be moved upward and downward within the gland. Its relation to the recurrent laryngeal nerve which enters the larynx indicated by *x* at the level of the horn of the thyroid cartilage is to directly overlie it.

X-ray examination revealed the classical picture of a relatively advanced hyperparathyroidism. Figures 6, 7, and 8 are films of skull and spine showing the typical changes as described.

The initial blood calcium was 17.2 milligrams, the blood phosphorus 2.5 milligrams, and the phosphatase activity 64.4. Pre-operative estimation of these values showed an average calcium of 13.3 milligrams, and a phosphorus varying at times from 2.5 to 1.7 milligrams. The blood non-protein nitrogen averaged 30 to 35 milligrams. The phenolsulphophthalein test showed a kidney function of 25 to 35 per cent. There was a very slight trace to a slight trace of albumin in the urine, with some slight fixation of the specific gravity by 1 hour examination. It was evident that there was some renal damage. The basal metabolism was plus 20. On a fixed amount of calcium intake the patient was shown to be in negative calcium balance.

Operation was done on May 15, 1933. A parathyroid adenoma was excised (P.H.L.). Beneath the lower left pole of the thyroid there was a definite tumor mass which descended into the chest. This mass was 1.5 inches long and about three-quarters of an inch in diameter (Figs 9 and 10). It was distinctly separate from the thyroid gland, except for some connecting alveolar tissue and blood vessels. An immediate frozen section revealed parathyroid tissue, and further histological study confirmed the diagnosis of an adenoma of the left lower parathyroid gland (Fig. 11).

Following operation, the patient developed definite tetany on the evening of the third postoperative day. Blood calcium at this time was 8.5 and the blood phosphorus 1.2. Intermittent signs of tetany severe at times, persisted until the thirtieth postoperative day. The tetany was controlled by administration of parathormone and large doses of calcium lactate by mouth. Viosterol capsules were also given. On discharge from the hospital she was instructed to take 5 grams of tribasic calcium phosphate daily and continue with the viosterol, drops 5, twice daily at this time. The blood calcium was then 7.8 milligrams and the phosphorus 2.4 milligrams.

November 17, 1933. Six months following operation blood calcium was 9.5 and the phosphorus 4.3 milligrams. The phosphatase activity was 7.5. The patient was entirely free of her aching discomfort in the back and extremities. She had taken calcium phosphate in small doses up until this time and showed no evidences of tetany.

December 3, 1934. Eighteen and one-half months following operation the blood serum calcium was 10 milligrams and phosphorus 4 milligrams. The phosphatase activity was 3.7 Bodansky units. The patient had not taken calcium for 1 year. She revealed no signs of tetany and was entirely free from any symptoms.

CASE 2. Mrs. Anita K., aged 53 years, housewife. This patient is of particular interest in that she is the only one of the group here reported, presenting definite evidence of hypertrophic arthritis associated with hyperparathyroidism.

May 2, 1933. She was admitted to the clinic because of painful knees and pain in the back of the neck region of 4 to 5 years duration, slowly but progressively becoming more pronounced. She had been treated elsewhere without relief by tonics, tomy medication, and various other forms of diet.

The significant clinical findings were as follows: A well developed, fairly well nourished, very tired and worn appearing Armenian woman of 53 years with moderate upper dorsal round back, crepitations in knee joints, plus some periarthritic thickening, and definite limitation of motion of the head due to pain. These symptoms were at first thought to be due simply to pronounced fatigue, associated with a moderately advanced hypertrophic arthritis. X-rays of the knees, showing the lower femora, however revealed a diffuse, although not pronounced osteoporosis (Fig. 12). Parathyroid disease was therefore suspected. X-rays of the cervical vertebrae (Fig. 13) were even more suggestive of the same condition, although they also revealed extensive hypertrophic changes. Plates of the skull were negative. No tumor could be felt in the neck. The patient was then advised to enter the hospital for investigation of possible hyperparathyroidism.

The blood calcium ranged from 12.5 to 14.0 milligrams, the phosphorus 3 milligrams to 2.3 milligrams. Careful metabolic studies revealed a definite negative calcium balance. The urine calcium excre-



Fig. 27 Case 4. Photograph of parathyroid adenoma

tion was 0.328 grams to 0.423 grams. The blood phosphatase activity however averaging 10.2 units was approximately normal, but in view of the relatively insignificant bone changes, this phosphatase finding was not felt to contra indicate definitely the diagnosis of hyperparathyroidism. This patient is classified in group 2 and in view of the hypercalcemia and X ray findings described exploration of the neck was advised.

June 7, 1933 operation was done (FHL). A definite mass about equal to a medium sized olive was felt beneath the right inferior thyroid artery. Following demonstration of the recurrent laryngeal nerve, the inferior thyroid artery was ligated and the tumor mass revealed. With very careful dissection, it was freed from the nerve, delivered, and removed (Fig. 14). An immediate frozen section diagnosis of parathyroid adenoma was made and later confirmed by further microscopic study (Fig. 15).

On June 24, 1933, 17 days following operation, the blood calcium had come down from an initial high reading of 14.9 to 9.7 milligrams, while the phosphorus had risen from an initial low reading of 2.2 milligrams to 3.8 milligrams. The urine calcium with an original high reading of 0.462 grams diminished to 0.109 grams.

At no time was there evidence of postoperative tetany. The patient's aches and pains, however persisted, especially in the neck and knee region until September 1, 1933, 3 months following operation, when symptoms were much less pronounced.

September 19, 1934, 15 months following operation blood serum calcium 10.7 milligrams phosphorus 3.5 milligrams. Patient reported that aching discomfort was still intermittently present in the neck region, but the severity of these pains was much less pronounced. The knee joint symptoms had disappeared. She felt greatly improved over preoperative condition.

CASE 3. Mrs. Ellouse S. aged 74 years housewife. The diagnosis of hyperparathyroidism in this patient rests upon the history, the X ray findings, and upon the operative and microscopic demonstration of an adenoma of the parathyroid gland. The blood chemistry was normal. Metabolic study showed a slight negative calcium balance but no more than

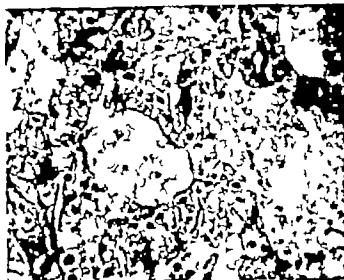


Fig. 28 Case 4. Photomicrograph of parathyroid adenoma $\times 500$

might be present in conditions other than hyperparathyroidism.

June 2, 1933 she was admitted to the clinic with a complaint of gitter nervousness, and severe leg pains. Patient gave a history indicative of three spontaneous fractures in the region of the right knee and the right ankle and left ankle during the past 6 years. All had healed, but considerable deformity resulted particularly in the region of the right knee.

Figures 16 and 17 are X ray films of the spine and show marked decalcification with pronounced compression of the eleventh dorsal and second and fourth lumbar vertebrae. Small cystic areas are seen in the pelvis. Plates of the femora (Fig. 18) show an old malunited fracture of the distal end of the right femur, as well as a more recent fracture of the medial condyle of this femur.

The highest blood serum calcium finding was 11.3 the average of 4 estimations was 10 milligrams per hundred cubic centimeters. The blood phosphorus varied from an initial reading of 1.0 to 3 milligrams. The blood phosphatase activity was 7.2.

June 8, 1933 operation was done (FHL). The left thyroid lobe was occupied by a discrete adenoma the size of a lime, and a small adenoma about the size of a cherry both of which were removed, and on examination presented the typical gross and microscopic appearance of multiple colloid adenomatous gitter. Very careful palpation of the atrophic right lobe of the thyroid revealed a small discrete tumor about a centimeter in diameter in the substance of the gland at its superior pole. The actual size of this adenoma of the parathyroid may be seen in Figure 19 made by the artist at the operating table. This mass was therefore removed and on immediate frozen section showed parathyroid tissue. Further microscopic study revealed an adenoma of the right upper parathyroid gland (Fig. 20).

The postoperative course was quite uneventful. There was at no time any suggestion of tetany.



Fig. 20. Case 3. Lateral X-ray roentgenogram of spine showing the generally diffuse even decalcification of the column. Crushing of the body of first lumbar vertebra suggestive of fracture but there was no history of trauma. Note absence of involvement of intervertebral discs.

August 11, 1933, patient reported for check up examination at which time the calcium was 10.2 and the phosphorus 3.3 milligrams. The aches and pains in the legs were considerably improved. She was still having symptoms referable to the mechanical defect resulting from the malunited fracture, for which the patient refused any further therapy. Further studies of the renal function at this time as well as investigations before operation did not reveal definite evidence of a renal insufficiency. The urine remained negative and the blood non-protein nitrogen was 30 milligrams.

January 24, 1934, 6 months postoperative, the patient reported that she was not bothered by the leg pains except those due to old fracture of the right knee region. December 7, 1934, 18 months following operation the blood serum calcium was 10.0 and the phosphorus 4.1 milligrams. The blood phosphatase was 3.3 Bodansky units. The original complaint of nervousness and leg pains no longer bothered patient.

CASE 4. Miss Rachel E. aged 44 years, clerk. This patient was originally admitted to the clinic in January 1930, for a multiple colloid adenomatous goiter, partly substernal, without evidence of toxicity. Excision of the goiter was advised and carried out in October 1930, and the patient made an uneventful recovery. At this time there was no evidence of an adenoma of the parathyroid gland, nor were there any clinical signs of hyperparathyroidism.

The patient next returned to the clinic in June, 1934, because of diffuse low back pain and pain in the knees and legs of 2 years duration. In this interval, particularly in the past 10 months, the patient described a progressive loss of stature with an increasing round back deformity. Figure 21 is a photograph of the patient at this time. There was no evidence of a tumor in the thyroid region.

Figures 22 and 23 are lateral and anteroposterior X-ray films of the spine which reveal practically complete destruction of the fifth thoracic vertebra from marked compression. The pronounced deformity of the thorax is evident. A lateral view of the skull (Fig. 24) shows typical gross decalcification with prominence of the trabeculae and the soft mottled appearance of hyperparathyroidism. Numerous multilocular cysts as found in advanced cases of classical form of the disease are illustrated in the X-rays of the pelvis (Fig. 25). X-rays of the genito-urinary tract revealed the kidneys to be of normal size and regular in outline. There was no evidence of stone.

Initial blood serum calcium values ranged from 14.4 to 15.1 while the serum phosphorus varied from 2.4 to 3.5 milligrams. The phosphatase activity was 35 Bodansky units. The remaining findings from the complete blood study were negative. The basal metabolism was +14.

Operation was done July 9, 1934 (F.H.L.). A tumor mass was found in the lower lateral side of the remnants of the right lobe of the thyroid gland. This tumor, about the size of a large walnut, lay partly beneath the inferior thyroid artery. In Figure 26 is shown an actual outline tracing around the parathyroid adenoma. Immediate frozen section diagnosis was adenoma of the parathyroid which conclusion was later confirmed by paraffin sections. Figure 27 is a part of the parathyroid adenoma removed and Figure 28 is a photomicrograph of the adenoma.

The postoperative course was uneventful. The blood calcium immediately came down to 0.2 and the phosphorus to 3.1 milligrams. Two weeks after operation, the serum calcium was 8.0 and the phosphorus 3.0 milligrams. The patient did not develop typical tetany. She spoke only of some slight numbness of the finger tips, which lasted 4 to 5 days following operation.

October 18, 1934, 3½ months following operation, the patient's general condition was excellent. She was free from the aches and pains of which she originally complained while the blood chemistry findings remained normal. The blood serum calcium was 9.0 and that of the phosphorus 3.6 milligrams. Patient was taking 1 heaping teaspoonful of calcium lactate by mouth three times a day. Otherwise, she occasionally experienced slight twitching sensations in her legs. The clinical signs of tetany were negative.

December 21, 1934, 5½ months following operation, the blood serum calcium was 9.6 milligrams and phosphorus 3.1 milligrams. The general condition was excellent. Patient felt very much better than she

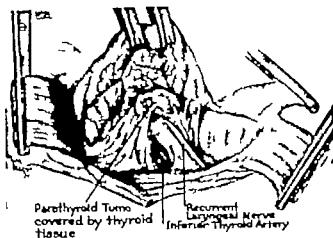


Fig. 30. Case 5. This parathyroid adenoma of the right inferior parathyroid was found at a location typical for inferior parathyroids at the point where they are most commonly seen in the course of thyroid operations.

The trunk of the inferior thyroid artery is shown and the course of the recurrent laryngeal nerve before it passes over or under the branches of the inferior thyroid artery. We have now dissected and visualized the recurrent laryngeal nerve several hundred times and are impressed with the fact that its course and location is dependably constant. Note that these tumors are not infrequently covered by a little thyroid tissue.

had at any time during the past 2 years. Her only complaint was occasional backache in the region of the kyphosis of the spine. These symptoms, however, were much less pronounced than they were before operation. She was continuing her calcium phosphate and lactate by mouth. No clinical signs or symptoms of tetany.

CASE 5. Mrs. Maude F. aged 52 years, housewife. February 22, 1934, patient entered the clinic because of aching pains throughout the body and a severe pain localized in the mid low back and running around into the abdomen. X-rays of the spine revealed a generalized decalcification. There was definite compression of the body of the first lumbar vertebra (Fig. 30). It was thought that these findings would adequately explain the patient's pain but in view of the decalcification of the bones, X-rays were also taken of the bones of the extremity and of the skull. The former were negative. The latter revealed a few mottled areas of irregular density with some actual thickening of the cortices. X-rays of the kidneys were negative for calculi.

The blood serum calcium ranged from 14.1 to 13.8 while the phosphorus varied from 2.1 to 2.0 milligrams. Phosphatase activity was 44.8 Bodansky units. The urine sediment revealed many white blood cells. The renal function test was normal.

Study of the X-rays of the spine first suggested that the compressed first lumbar vertebra might be the result of an old fracture, as there was definite increased density in the body of this bone. Paget's disease was considered. To rule out the possibility of any intraspinal pressure two lumbar punctures



Fig. 31. Case 5. Photomicrograph of parathyroid adenoma removed from this patient. $\times 500$.

were performed with normal dynamics and with clear spinal fluid. The total spinal fluid protein was 50 milligrams. There was a cell count of 1 and a colloidal gold of 1:121,100,000. The calcium estimation in the spinal fluid was 6.0 milligrams.

In view of the laboratory findings, the fact that the patient was in negative calcium balance, the demonstration of a multiple colloid adenomatous goiter and the probability of a tumor of the parathyroid—it was decided to explore the thyroid gland, remove the adenomatous goiter and search for a parathyroid adenoma. It was concluded that the patient presented strongly suggestive evidence of hyperparathyroidism and that she also probably had a mild form of Paget's disease.

March 10, 1934, operation was done (FHL). An exposure of the thyroid region revealed a marble sized adenoma of thyroid tissue in the left lower lobe. At the right inferior pole, the typical position of a parathyroid body, a discrete tumor the size of a large lima bean was found in immediate relationship to the inferior thyroid artery and the recurrent nerve. The parathyroid adenoma shown in the artist's drawing (Fig. 30) made at the operating table is about half the actual size. This mass was excised and on frozen section a diagnosis of parathyroid adenoma was made. This was later confirmed by complete histologic studies (Fig. 31).

Following operation the blood serum calcium was reduced to an average between 7.8 and 8.2 milligrams, while the phosphorus varied between 2.4 and 3.7 milligrams. Three days following operation the patient had a transitory attack of tetany with a positive Chvostek sign and numbness of the extremities. All symptoms of tetany were relieved by parathormone and by calcium lactate, grams 32 daily. She was discharged from the hospital 21 days after operation, entirely free from tetany. She was advised to continue 1 heaping teaspoonful of calcium lactate twice daily, 2 viosterol capsules, daily.

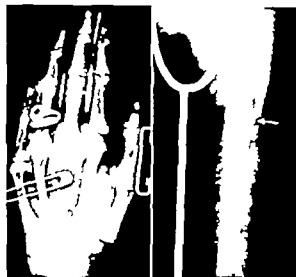


Fig. 32 a and b. An X-ray picture of the case of hyperparathyroidism seen in consultation with Dr. R. C. Cochrane. The two normal parathyroids had already been removed without relief of the hyperparathyroidism. At the suggestion of one of us (F.H.L.) an intrathyroid parathyroid adenoma was found and removed at a third operation. It is shown to demonstrate the advanced state of decalcification in Figure 32a and the very slight reaction in the cortex in Figure 32b, the point of a spontaneous fracture.

Following operative convalescence progressive hyperextension of the spine was instituted to prevent further compression of the first lumbar vertebra. This treatment had to be discontinued because the patient would not co-operate. We were successful in securing the patient's agreement to wear a high supporting corset.

May 15, 1934, 2 months following operation the blood serum calcium was 10.1 milligrams and the phosphorus 4.9 milligrams, while the phosphatase activity was 35.0 Bodansky units. It was necessary to administer parathormone subcutaneously and calcium lactate by mouth to prevent constant tingling sensations and numbness in the extremities.

July 13, 1934, 4 months postoperative this patient had gained 12 pounds in weight. Her chief complaint still was "kinking" in the low back. Blood serum calcium 11.2 milligrams, phosphorus 5.1 milligrams, and phosphatase 25.0 Bodansky units.

December 15, 1934, 8 months after operation, her general condition was still further improved. She had gained 10 pounds in weight. There were no clinical signs of tetany but she required calcium lactate (grains 45) daily by mouth, to feel good. The back pain referred to the lumbodorsal region was intermittently severe.

X-rays of the spine showed apparent normal calcification. The first lumbar body was compressed more than when first seen and was very dense. There was some early hypertrophic lipping of this vertebral

body and of the bodies of the adjacent twelfth dorsal and second lumbar vertebrae.

Blood serum calcium was 9.8 milligrams phosphorus, 3.5 milligrams and phosphatase, 5.8 Bodansky units.

The back pain is now due entirely to the mechanical derangement of the lumbodorsal spine as a result of the compression of the body of the first lumbar vertebra. Early hypertrophic changes have also appeared. To date patient refuses treatment for this condition (Fig. 32).

The hyperparathyroidism is relieved.

SUMMARY

Five new proved cases of hyperparathyroidism due to parathyroid adenomata are recorded together with the findings which lead to their diagnosis.

The clinical aspects, the blood chemistry and the bone changes are discussed.

The appearance of normal and abnormal parathyroids is discussed. The normal and abnormal location of parathyroids is presented in graphic form.

The five proved cases of hyperparathyroidism together with X-rays of the bones in these cases. Illustrations made at the operating table of the demonstration of the parathyroid tumors in such cases and microscopic slides of the tumor are submitted.

We must all particularly the orthopedist and the urologist be on the lookout for hyperparathyroidism in patients complaining of pain in the back or extremities, in patients with diffuse neuritis or arthritic pains made worse on motion in patients with progressive loss in stature and in patients with kidney stones. Many patients with hyperparathyroidism who could be relieved of their condition by surgical removal of a parathyroid adenoma have in the past and are doubtless still passing through our hands with their condition unrecognized.

BIBLIOGRAPHY

- ALBRIGHT, F., BAIRD, P. C., COPE, and BLOOMFIELD. Renal complications of hyperparathyroidism. *Am. J. M. Sc.* 934: 47, 1937.
- ALBRIGHT, F., AXT, J. C., BAKER, W. Hyperparathyroidism. *J. Am. M. Ass.* 954: 22, 1936.
- BAUER, J. Hyperparathyroidism and related states. *Beitr. klin. Chir.* 934: 59, 1933.
- BAUER, WALTER. Hyperparathyroidism: a distinct disease entity. *J. Bone & Joint Surg.* 933: 15, 1935.
- BODANSKY, A. Determination serum phosphatase. *J. Biol. Chem.* 933: 91, 1933.

- 6 CAMP J S. Osseous changes in hyperparathyroidism. *J Am M Ass* 1932 99 1913
- CHURCHILL and COPE. Parathyroid tumors associated with hyperparathyroidism. *Surg Gynec. & Obst* 1934, 58 255
- 7 DREXLER K. Osteitis fibrosa cystica associated with parathyroid activity. *Am J Roentgenol* 1933 30 596.
- 8 GUTMAN A B, SWENSON P C and PARSONS, W B. The differential diagnosis of hyperparathyroidism. *J Am Ass* 1934, 103 87
- 9 HÖRREDEZ. Ueber Vergrößerungen der Epithel Körperchen der Osteitis Fibrosa und verwandten krankheits Bildern. *Arch f path Anat* 1925 256 705
- 10 JURY, H L. Hyperparathyroidism. *Arch Path* 1933 16 63 236
- 11 JURY, HOOANIKY and BLAIR. The sites of decalcification and bone lesions in experimental hyperparathyroidism. *Arch Path* 1931 12 715
- 12 KLEINBOCK, R. Paget's disease of bones and parathyroid tumors. 1934, 1610 159 597 (June 6)
- 13 MAXIM, F. Zur Technik der Parathyroidektomie bei Osteitis Fibrosa auf Grund neuer Beobachtungen. *Deutsche Ztschr f Chir* 1933 240 362
- 14 WILDER, R. M. Tumor of parathyroid glands and osteitis fibrosa. *Endocrinology* 1929 13 231

HISTORICAL AND GENERAL SURVEY

- 1 BARR BULGER DIXON. Hyperparathyroidism. *J Am M Ass* 1929, 92 951
- 2 BAUER, W., ALBRIGHT and RICHARDSON. *J Clin Invest.* 1929-1930, 8 229
- 3 GOLD E. Ueber die Bedeutung der Epithel Körperchen Grösserung bei der Osteitis Fibrosa Generalisata. *Mitt. u d Grenzgeb d Med. u Chir* 1928, 41 63
- 4 HAMMON SUHRM McCLIFLAN and DuBOIS. *J Clin Invest.*, 1929-1930, 8 215
- 5 HUNTER D and TURNBULL, H M. Hyperparathyroidism. Generalized osteitis fibrosa. *Brit J Surg* 1931 19 203
- 6 KAY H D. Phosphatase in growth and disease of bone. *Physiol Rev* 1932 12 384
- 7 MANELL, F. Therapeutischer versuch bei einem Falle von Osteitis Fibrosa generalisata Mittels extirpation eines Epithelkörperchen tumors. *Zentralbl f Chir* 1926, 53 260
- 8 Idem. Klinisches und Experimentelles zur Frage der lokalisierten und generalisierten Osteitis Fibrosa. *Arch f Klin Chir* 1926, 143 245
- 9 MORTON J J. Generalized type osteitis fibrosa cystica. *Arch Surg* 1922 4 534
- 10 THOMSON, D L and COLLIP J B. The parathyroid glands. *Physiol Rev* 1932 12 309

MECHANISM, SYMPTOMS, AND TREATMENT OF HERNIA INTO THE DESCENDING MESOCOLON (LEFT DUODENAL HERNIA)

A PLEA FOR A CHANGE IN NOMENCLATURE¹

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IT is our purpose in this paper to elaborate upon several phases of the so called left duodenal variety of intraperitoneal (internal) hernia. First we shall report a case of a complete rupture of this type an attempt will be made to explain the hernia on an embryologic basis reasons will be adduced to justify a change in the nomenclature of this lesion. The symptoms and signs consequent upon strangulation of the hernial contents and the methods of treatment of this variety of hernia will be mentioned.

REPORT OF CASE

A male E.S. 40 years of age, was admitted to the Mount Zion hospital because of rheumatic heart disease. His death in the hospital was the result of chronic mitral valvulitis, obliterative pericarditis, and lobar pneumonia. In the course of his hospitalization he gave no history and presented neither signs nor symptoms of the unusual intraperitoneal hernia which he presented at autopsy examination.

Our interest in the postmortem examination centered about an enormous hernial sac (Fig. 1) within which practically all of the jejunum-ileum was incarcerated. When the abdominal cavity was opened, the stomach, duodenum, liver and spleen were in their proper positions and had maintained their normal relationships. The cecum and the ascending, transverse, and descending divisions of the colon were in the normal inverted U position. The ascending and descending mesocolon and the segments of large bowel attached to the mesocolon were applied and normally adherent to the posterior parietal



Fig. Appearance of hernial mass of jejunum-ileum. The topography of the colon is normal. All but about 5 centimeters of the jejunum-ileum is incarcerated in the sac derived from descending mesocolon. In this drawing the neck of the sac is shown as open, blunt and sharp dissection was required to demonstrate the opening. The ascending branch of the inferior mesenteric artery and the inferior mesenteric vein are in the anterior wall of the neck of sac.



Fig. An incision was made in the peritoneal layer, in an avascular area, in the anterior wall of the hernial sac. The jejunum-ileum is seen through the rent in the sac.

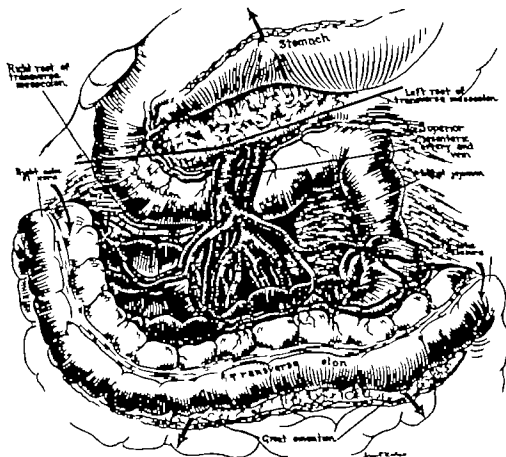


Fig. 3 Dissection in recorded case of region about the transverse division of the duodenum and the initial jejunum. This drawing was made to show that the duodenum lay behind the superior mesenteric vessels. The colic angles are depressed to allow illustration of the distribution of the superior mesenteric vessels to the ascending and transverse colons.

peritoneum. The sigmoid colon was omega in shape and was suspended by a mobile mesentery.

Only the terminal 5 centimeters of the small bowel could be seen; the remainder of the jejuno-ileum lay within a hernial sac produced at the expense of the descending mesocolon and formed a large left-sided abdominal tumor. The forward wall of the hernial sac was the descending mesocolon, the serosal duplication of which contained the ascending branch of the inferior mesenteric artery and the inferior mesenteric vein, both of which stood out prominently. The location of the neck of the sac at first was not apparent for the reason that the margins of the orifice were united by peritoneal agglutination. However, blunt dissection about the duodenojejunal angle disclosed the neck of the sac which was a palm's breadth in length and demonstrated its several margins. There was no evidence of periduodenal folds or fossae. In the forward margin of the sac ran the ascending branch of the inferior mesenteric artery and the main trunk of the inferior mesenteric vein. In the inferior limit of the neck of the sac was the concavity of the upwardly arching course of the ascending branch of the inferior mesenteric artery. The superior boundary of the neck of the sac was the inferior mesenteric vein which ran in

a medial direction to contribute to the formation of the portal vein. The posterior boundary of the neck of the sac was the primitive midline attachment of the descending mesocolon.

An incision was made through the peritoneal layers which form the anterior wall of the sac, i.e. through an avascular area of the descending mesocolon and the jejuno-ileal contents of the sac were exposed (Fig. 2). Had strangulation taken place within the sac, an incision so placed as to avoid injury to the blood supply of the descending colon would have been used to determine the cause of obstruction and to restore alimentary continuity. Figure 4 shows all of the small bowel exteriorized through a large opening in the anterior wall of the sac. There were no adhesions between the contents of the sac and the sac wall.

The contents of the sac were then replaced and the intestinal coils were drawn to the right through the neck of the sac into the general abdominal cavity as is illustrated in Figure 5. It is evident that the root of the mesentery of the small bowel is much shorter than that found in the normal abdominal cavity. The drawing indicates the degree to which the inferior or distal coils of small bowel are bunched or clumped. The anatomical explanation for the



Fig. 4. All of the jejunum-ileum has been withdrawn through the rent in the anterior wall of the hernial sac. There are no adhesions between the hernial contents save at the neck of the sac.



Fig. 5. Mass of jejunum-ileum withdrawn through neck of sac into general abdominal cavity. The rent in the anterior wall of the sac noted in the foregoing drawings is retracted with hooks. The dissected area shows the upward course of the ascending branch of the inferior mesenteric artery and the inferior mesenteric vein. Both vascular trunks run in the anterior wall of the neck of the sac and constrict the sac orifice.

clumping of the distal loops of small bowel lies in the overlapping of the small bowel mesentery in its terminal portion. The mesentery at and near its root is compressed and partly turned upon itself to such a degree that two-thirds of the small bowel seem attached to that part of the mesentery which apparently has no more than 5 centimeters of posterior attachment.

Attempts made to separate the layers of peritoneum which form the walls of the sac were unsuccessful in demonstrating how many primitive layers were present before embryologic coalescence of opposed serous surfaces took place. A determination of the number of primitive peritoneal layers involved also was attempted by sectioning tissue blocks of the sac walls. The formation of coalescent fusion fascias rendered layer differentiation impossible.

GASTRO-INTESTINAL EMBRYOLOGIC BACKGROUND FOR INTERPRETATION OF THIS HERNIA

Before attempting to explain the variety of mechanisms by which this intraperitoneal hernia occurs it is necessary to review the essential stages in the development of the gastro-intestinal tract and its associated peritoneum.

The early alimentary canal traverses the future abdominal cavity of the embryo as a straight tube suspended from the dorsal wall by a common dorsal mesentery (Fig. 6). The tube is suspended anteriorly over the superior portion of its extent by the ventral common mesentery. As compared with the gradual growth of the embryo in length, disproportionately large growth occurs in the primitive digestive tube—one which results in the segmentation of the tube into its ultimate constituents, the stomach and the small and large bowel.

Differentiation of the tube results in a differentiation within its carrying mechanism, the dorsal and ventral mesenteries. These are subdivided into the dorsal and ventral mesogastric, the mesoduodenum and the mesenterics of the small and large bowel. The distribution of the branches of the aorta to each segment of the alimentary tube takes place

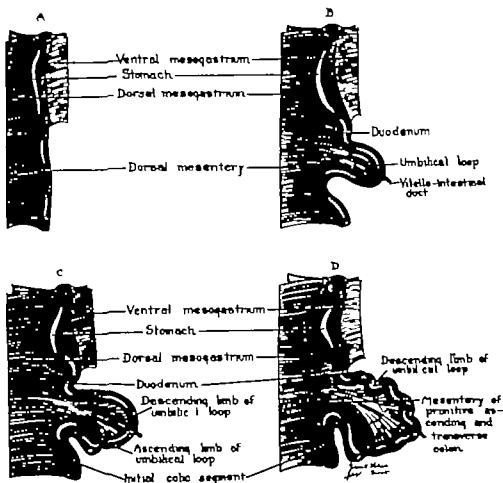


Fig. 6 Development of the gastro-intestinal tract from the primitive sagittal allmentary tube to the umbilical loop stage. A The primitive stomach is shown as a fusiform swelling with its greater curvature directed dorsally. The ventral mesentery extends a little beyond the stomach. B The gastric curvatures are more differentiated. The umbilical loop is suggested. The mesentery of the loop hypertrophies to accommodate the increase in length of the intestinal tube which forms the loop. C, The ascending limb of the loop at the point which marks the ileocecal junction, enlarges and forms the cecum, or beginning of the initial segment of the colon. D The small intestine segment of the loop (jejunum-ileum) increases in length, as shown by the fluting. The differentiation of the dorsal common mesentery into segments is indicated.

while the tube and mesenteries are in the primitive sagittal position.

The structural changes in the tube are not all those of simple elongation for there are changes in form and capacity as well. The cephalic portion of the canal bulges into a fusiform swelling the stomach. The middle portion lengthens into the redundant umbilical loop of which the descending limb and part of the ascending limb constitute small intestine and the remainder of the ascending limb becomes the initial part of the large bowel. The terminal part of the alimentary tube is transformed into a long uniformly large segment the remainder of the large bowel.

While these changes occur the glands annexed to the digestive tract develop between the peritoneal duplications which make up the dorsal and ventral mesenteries, these are the liver spleen and pancreas. The spleen develops independently of the gastro-intestinal tube but the liver and pancreas arise as outgrowths from it (Fig 7).

The rotation and posterior fixation of the gastroduodenal segment of the alimentary tract will not be discussed at length because the changes which take place in this segment have no bearing upon the mechanism of left duodenal hernia. The stomach in this rotation is the central and pivotal viscus. The first rotation of the stomach is about its long

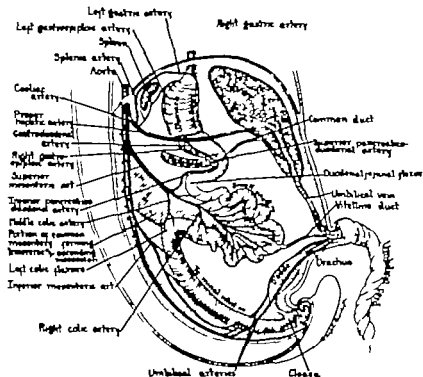


Fig. 7 Diagrammatic sagittal section of an embryo at the completion of the umbilical loop stage of development. The celiac artery supplies the gastroduodenal segment, the superior mesenteric artery the umbilical loop, and the inferior mesenteric artery supplies the terminal intestine. (Callander's *Surgical Anatomy* Courtesy W. B. Saunders Co.)

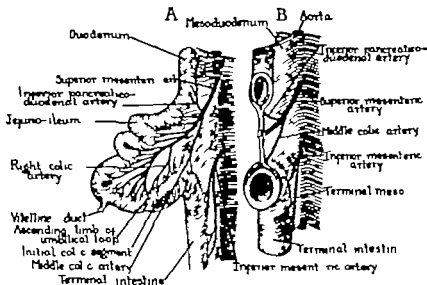


Fig. 8 Sagittal diagram of the umbilical loop and terminal intestine segments prior to rotation. In A, the umbilical loop is attached, and in B it is removed to show the distribution of the superior mesenteric artery. The superior mesenteric artery is the axis of the loop about which rotation occurs. The inferior mesenteric artery is the vascular supply of the terminal intestine. (Callander's *Surgical Anatomy* Courtesy W. B. Saunders Co.)

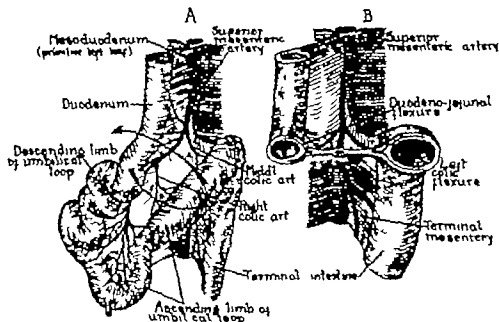


Fig. 9. Umbilical loop segment after a counter clockwise rotation of 90 degrees. In A, the loop maintains its duodenal and terminal colon connections. In B the ascending and descending limbs of the loop are removed to show the disposition of the mesentery and the enclosed arterial supply. The arrow indicates the direction of the succeeding stage of rotation (Callander's *Surgical Anatomy* Courtesy W B Saunders Co)

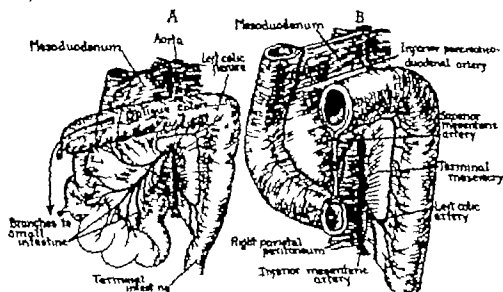


Fig. 10. Disposition of the structures formed from the umbilical loop after its rotation to the oblique colon stage. In A, the elements of both limbs of the loop maintain their duodenal and terminal colon connections. In B the elements of both limbs of the loop are removed (Callander's *Surgical Anatomy* Courtesy W B Saunders Co)

axis and the second rotation about its antero-posterior axis. The rotation of the stomach upon its anteroposterior axis folds the initial part of the primitively sagittal duodenum and its mesentery and contents against the right primitive parietal peritoneum, to which they become fused by the process of fetal peritoneal 'agglutination'

An understanding of the rotation and posterior fixation of the umbilical loop segment of the gastro-intestinal tract is essential to the comprehension of the mechanism of left duodenal hernia. We have referred to the initial part of the duodenum as having been brought to the right across the median line by the rotation of the stomach about its antero-

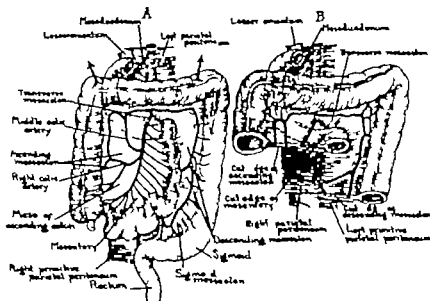


Fig. 1. Final stage of umbilical loop rotation. In A, the intestinal structures are in place after the completion of rotation and the formation of the ascending and transverse colon segments from the oblique colon. In B most of the ascending colon and mesocolon and the jejunum-ileum and its mesentery are removed. The superior mesenteric artery is the boundary between the mesentery of the ascending colon and the mesentery of the jejunum-ileum (Callander's *Surgical Anatomy* Courtesy W. B. Saunders Co.)

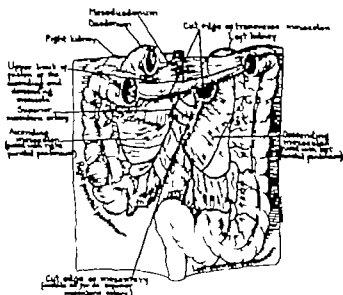


Fig. 2. Diagram to show the mesenteries of the ascending, transverse, and descending portions of the colon in their ultimate positions prior to posterior peritoneal fixation. The jejunum-ileum is cut away to show its mesentery which remains mobile. The root of the mesentery is along the line of the superior mesenteric artery (Callander's *Surgical Anatomy* Courtesy W. B. Saunders Co.)

posterior axis. The distal part of the duodenum is the connection between the gastroduodenal segment and the umbilical loop. The colic angle or the inferior connection of the loop is the junction between the distal end of the umbilical loop and the terminal intestine. The ultimate position of the terminal part of the duodenum is dependent upon the rotational changes of the umbilical loop since these changes affect the position of the superior and inferior connections or points of suspension of the loop the former of which includes the terminal duodenum.

In order to make clear the various changes in position undergone by the umbilical loop it will be helpful to follow these changes in position as illustrated in Figures 8 to 11 inclusive as though one were producing them manually.

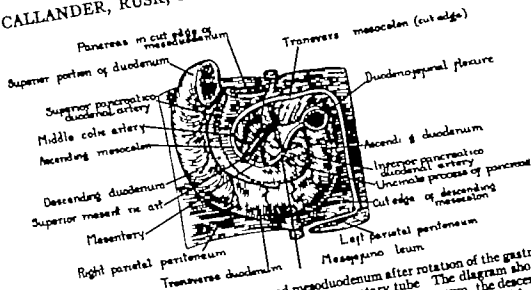


Fig. 13 Diagram of the duodenum and mesoduodenum after rotation of the gastrointestinal tube. The diagram shows how these structures are applied and fixed to the underlying peritoneum: the descending duodenum and part of the transverse duodenum are applied to and fuse with the primitive right parietal peritoneum. The remainder of the transverse duodenum and the ascending duodenum are applied to and fuse with the descending mesocolon. The duodenojejunal angle fuses partly with the inferior part of the transverse mesocolon (Callander's *Surgical Anatomy* Courtesy W B Saunders Co)

After rotation is complete the ascending, transverse, and descending portions of the colon are illustrated as having been carried to their ultimate position of an inverted U with the loops of the jejunum and ileum surrounded by the large bowel as by a frame. The key to the permanent and fixed arrangement of the segments of the gastro-intestinal tract lies in the manner of their posterior peritoneal fixation. The cecum, ascending colon, and the ascending mesocolon fuse with the right primitive parietal peritoneum over that area included between the trunk of the superior mesenteric artery and the lateral margins of the ascending colon. The transverse colon and mesocolon do not fuse with the primitive and mesocolon do not fuse with the primitive posterior parietal peritoneum but make up a more or less mobile unit. Posterior peritoneal agglutination binds the descending colon and mesocolon to the left primitive parietal peritoneum.

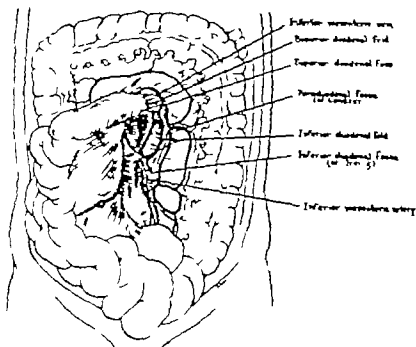
Our interest in recording the steps in gastrointestinal fixation centers about the terminal duodenum. It will be noted by referring to Figure 13 that the terminal duodenum and its mesentery and the continuous mesentery of the transverse and descending colon are superimposed structures before peritoneal agglutination takes place. The descending

mesocolon fuses with the left parietal peritoneum, and the ascending duodenum and its mesentery and the duodenojejunal angle fuse to the underlying mesocolon. The degree of fixation of the terminal duodenum to the mesocolon determines the strength of adhesions which bind down this segment of bowel to the mesocolon. If the adhesion of the duodenum to the mesocolon is strong the superior and inferior duodenal (duodenojejunal) folds are shortened and the recesses they roof (superior and inferior duodenal fossae) are shallow and small. If, on the other hand, the adhesion of the duodenum and its mesentery to its mesocolon is loose then these folds are large and the fossae which they roof are broad and deep.

THE FOSSAE ABOUT THE TERMINAL DUODENUM

In an analysis of the mechanism of hernia into the descending mesocolon a detailed description of the recesses about the terminal duodenum must be given because one or several of these fossae undoubtedly may be the point of entrance of small bowel in the development of this type of rupture. The most important of these recesses are the superior

A



B

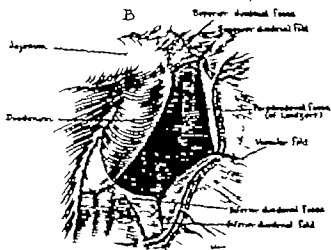


Fig. 14. A, Topography of the duodenojejunal junction and periduodenal folds and fossae. The arrangement of the vessels in the descending mesocolon as indicated. B, The most important periduodenal folds and fossae. Attention is directed to the course of the vascular trunks noted in A. They run in the fold overhanging the periduodenal fossa (of Landzert). (Modified from Callender's *Surgical Anatomy* Courtesy W. B. Saunders & Co.)

duodenal inferior duodenal, and the para duodenal fossae.

The superior duodenal fossa is the most constant of the peritoneal depressions situated about the ascending portion of the duodenum and to the left of the termination of this segment of the small bowel. The fossa lies at the level of the second lumbar vertebra and is bounded anteriorly by the superior duodenal

fold, a duplication of peritoneum which is essentially an embryological adhesion between the termination of the duodenum and the inferior surface of the transverse mesocolon near its union to the descending mesocolon. The inferior or free margin of the fold is concave, its mesal extremity blending with the peritoneum over the anterior surface of the terminal duodenum and its lateral extremity

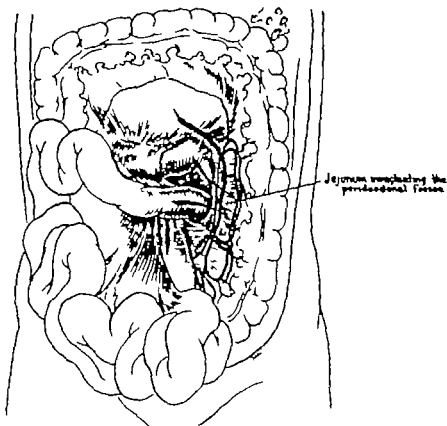


Fig. 15 Invagination of periduodenal fossa and later of descending mesocolon by initial knuckle of jejunum. The invagination is mainly into the paraduodenal fossa (of Landzert)

fusing with the ultimate parietal peritoneum at the junction of the transverse and descending mesocolon 1 c, anterior to the left kidney. The lateral attachment of the superior duodenal fold may be mesal or just lateral to the course of the inferior mesenteric vein, hence the designation of this fold as a 'vascular plica'. The orifice of the superior duodenal fossa looks inferiorly and its apex extends superiorly sometimes as far as the body of the pancreas.

The inferior duodenal fossa (of Treitz) lies to the left of the ascending portion of the duodenum on a level with the third lumbar vertebra. Its orifice looks superiorly directly into the orifice of the superior duodenal fossa. The closed end of the fossa points inferiorly and to the right toward the mesentery of the proximal jejunum. The cavity is bounded anteriorly by the inferior duodenal fold the free margin of which is thin and sharply demarcated. Its medial extremity blends with the peritoneum over the anterior surface of the ascending duodenum and its lateral

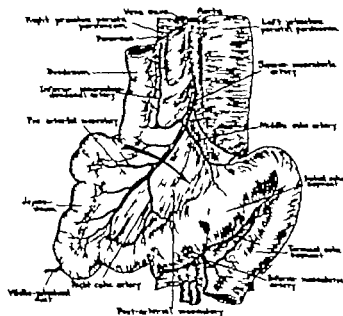


Fig. 16 Position of the small and large bowel at end of first stage of rotation. The arrow indicates the direction taken by the jejunum-ileum in invaginating the postarterial mesentery (ultimate ascending and transverse mesocolon). This drawing is explanatory of Haymond and Dragstedt's case of anomalous rotations. This and the following drawings were made as modifications of their drawings in an attempt to illustrate in 3 dimensions the anomaly they report.

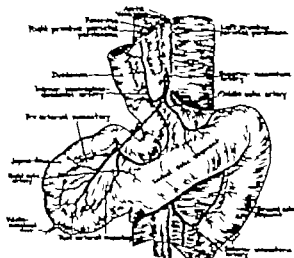


Fig. 17. Invagination of the postarterial mesentery by the small bowel. The duodenum, instead of rotating counter-clockwise behind the superior mesenteric artery crosses anterior to the artery and is beginning to invaginate the postarterial mesentery (ultimate ascending and transverse mesocolon). The initial colic segment ultimately will become the ascending and transverse divisions of the colon.

extremity fuses with the peritoneum of the descending mesocolon (ultimate posterior parietal peritoneum). The inferior mesenteric vein and left colic artery usually lie well to the left of the lateral attachment of the inferior duodenal fold although occasionally this

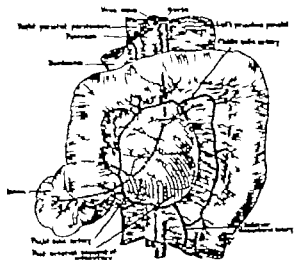


Fig. 19. Invagination of the postarterial mesentery by the small bowel. The mass of small bowel continues to invaginate the postarterial mesentery. The initial colic segment now rotates and elongates until the ascending and descending divisions of the colon are visualized.

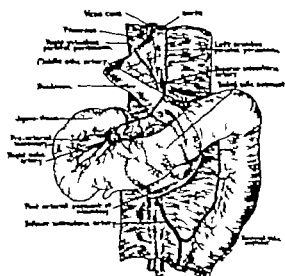


Fig. 18. Invagination of the postarterial mesentery by the small bowel. Much of the duodenum and jejunum now has pocketed itself into the postarterial mesentery. The oblique colon as yet has not become differentiated into the ascending and transverse colon.

vein has been found in the posterior wall of the fossa under discussion. The inferior duodenal fossa usually can accommodate the first phalanx

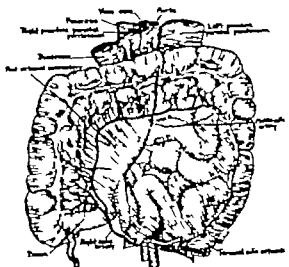


Fig. 20. Invagination of the postarterial mesentery by the small bowel. The divisions of the colon now are in their normal positions. The mass of jejunum-ileum is contained in a sac derived from postarterial mesentery. Most of the sac and contents lie to the left of the midline. Both the duodenum and terminal ileum cross anterior to the superior mesenteric artery. This schema represents the final stage in the production of the anomaly observed by Haymond and Dragstedt.

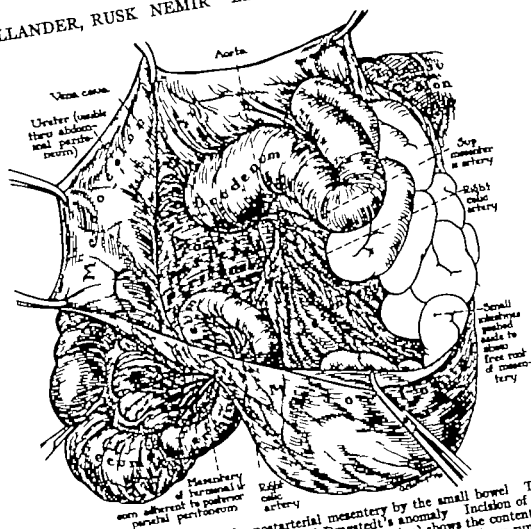


Fig. 21. Invagination of the postarterial mesentery by the small bowel. This drawing is a photograph of Haymond and Dragstedt's anomaly. Incision of the postarterial mesentery (ascending and transverse mesocolon) shows the contents of the sac at autopsy. It is obvious that the duodenum and the terminal ileum run anterior to the superior mesenteric artery. (From Haymond and Dragstedt, *Surg Gynec. & Obst.* 1931 53:323)

of the middle finger. Occasionally the fossa extends into the region posterior to the ascending portion of the duodenum a result of inadequate peritoneal fixation of this portion of the bowel.

The *paraduodenal fossa* (of Landzert) frequently exists in conjunction with the fossa just described. It is located at the left and quite a distance from the ascending portion of the duodenum and is a cavity produced by the elevation of a fold of peritoneum by the inferior mesenteric vein. This fold has been aptly termed the fold of the inferior mesenteric vein in its course within the descending mesocolon; hence, the varying distance from the terminal duodenum of the peritoneal fold which contains this vessel. The floor of the paraduodenal fossa is the peritoneum of the descending mesocolon

(ultimate posterior parietal peritoneum). The mouth or neck of the fossa is wide and opens inferiorly and to the right, and its closed extremity is directed superiorly and to the left. When the paraduodenal fossa occurs in conjunction with the superior or the inferior duodenal fossa or with both there usually is an amalgamation of the folds roofing the orifices of the fossae.

The *posterior or retroduodenal fossa* occurs occasionally especially in conjunction with a large paraduodenal fossa. The posterior duodenal fossa lies immediately behind the superior part of the ascending division of the duodenum, and is the result of a lack of fusion between the terminal part of the duodenum and the underlying ultimate posterior parietal peritoneum (primitive descending mesocolon).

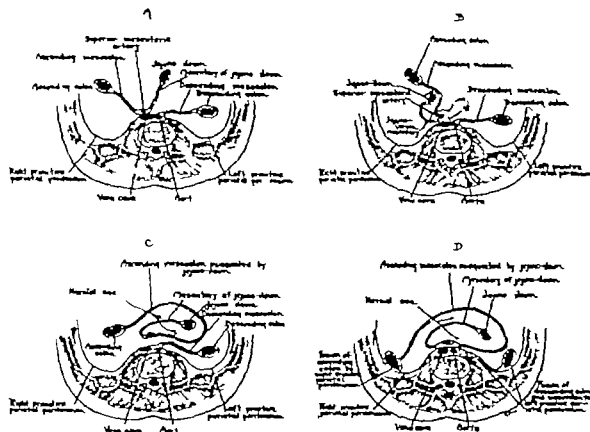


Fig. 23 Series of cross sections showing invagination of the postarterial mesentery by the small bowel. A, indicates the level at which invagination occurs. The jejunum-ileum and ascending colon are on a continuous mesentery. The ascending and descending mesocolons as yet are not fused to the posterior parietal peritoneum. The jejunum-ileum occupies its normal position after proper rotation has taken place. In B, the small bowel is illustrated as not having gained its normal position, as in A, by rotating behind the superior mesenteric artery but by rotating clockwise and

invaginating the ascending mesocolon. In C, the small bowel continues to invaginate and makes a hernial sac of the ascending mesocolon. The ascending colon is dropping down, preparatory to fusing with the right primitive parietal peritoneum. In D, the ascending colon has fused with the right primitive parietal peritoneum. The descending colon and the mesocolon have fused with the left primitive parietal peritoneum. The small bowel is enclosed in a hernial sac which is comprised of the ascending mesocolon.

There can be little doubt that the peritoneal duplications which delimit the periduodenal fossae are fusion or adhesion folds which are the result of fetal agglutination or fixation. We have noted in the section devoted to the development of the gastro-intestinal tract how the terminal duodenum is rotated against, and becomes adherent to the free peritoneal surface of the transverse and descending mesocolon. Hyperfixation which results in strong agglutination of the opposed surfaces, makes for short folds and shallow fossae. Hypofixation results in longer folds and deeper fossae. Adhesions have been noted in the embryo in this region at the middle of the fourth fetal

month. At this early stage these adhesions are delicate and non resistant. In embryos of greater age the adhesions are denser and are capable of withstanding considerable tension.

THEORIES OF HERNIA DEVELOPMENT

Accredited mechanism of hernia development. As a result of the fundamental work by Treitz, Moynihan, Landzert Broesike, and others, the genesis of the so called left duodenal type of hernia has been associated with the periduodenal fossae. Almost all investigators of the lesion agree that it usually begins in early fetal life. The initial portion of the jejunum is assumed to be invaginated into

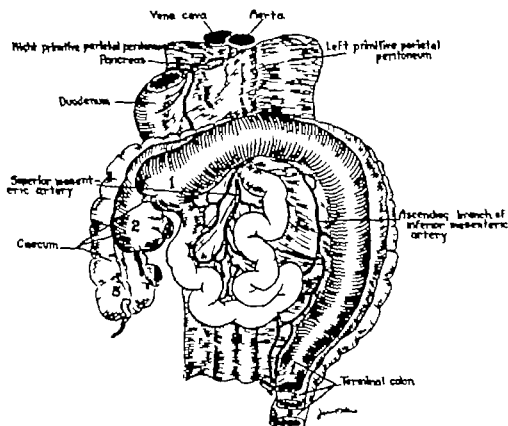


Fig. 23. Drawing indicating successive positions of large bowel and the mesocolon. The numbers indicate the stages in the progressive increase in size and in the placement of the large bowel and mesocolon.

the paraduodenal fossa (of Landzert) or into the inferior duodenal fossa (of Treitz) or into a combined fossa (of Treitz and Landzert). By a mechanism altogether obscure the bowel gradually enlarges the fossal sac until a smaller or greater part of the jejuno-ileum is invaginated and lost to view.

That the periduodenal fossae with their overhanging folds do offer areas of easy engagement for the small bowel is incontrovertible, it seems certain that many small ruptures of the type of hernia under discussion occur in which the periduodenal folds and fossae are clearly delimited and the fossae are occupied by one or more knuckles of small bowel. It is to be expected that the anterior part of the neck of the sac contain one or more of the constricting trunks of the inferior mesenteric vein and the ascending branch of the left colic artery.

It is still a matter of conjecture whether the hernia develops altogether *in utero* or whether the enlargement of the sac continues after birth. It seems reasonable to assume that the

sac reaches its maximum size in fetal life since during part of that period the descending colon is attached to a mesocolon sufficiently mobile to be invaginated easily and to contribute to the formation of a sac. There are those however who insist that the enormous sac required to house virtually all the jejuno-ileum may be formed after the primitive mobile descending mesocolon has been fixed to the primitive left parietal peritoneum.

In assuming that one of the periduodenal fossae particularly the paraduodenal fossa is the point of origin of this rupture and that these fossae are depressions in the descending mesocolon it is necessary also to assume that this increase in the size of the sac must be at the expense of the descending mesocolon. This must be by the progressive process of invagination irrespective of the size which the hernia attains.

Invagination of the combined ascending and transverse mesocolon (post-arterial mesentery) by the small bowel. Haymond and Dragstedt have described a most unusual type of intra

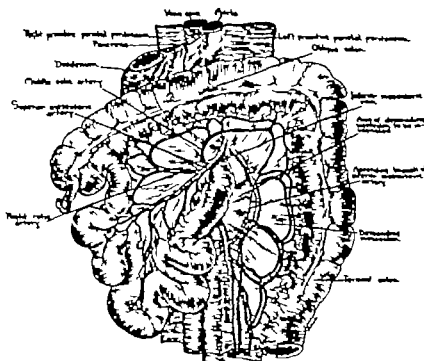


Fig. 24. Diagram of small and large bowel and their attached mesenteries in a stage of almost complete rotation. Posterior peritoneal fixation has not occurred as yet. The stippled area in the continuous transverse and descending mesocolons indicates the vascular area invaginated, according to our hypothesis, by the coils of jejunum-ileum before posterior peritoneal fixation has taken place.

peritoneal hernia. Their hernia is the result of an anomaly in the second stage of gastro-intestinal rotation in which the jejunum-ileum comes to occupy an abnormal position by invaginating the mesentery of the primitive ascending and transverse colon. We have modified certain drawings of these authors and have regrouped them in an attempt to make more clear the mechanism of the hernia they describe.

Figure 16 illustrates the midgut at the end of the first stage of rotation when the mass of jejunum-ileum is in the right side of the abdomen and the segments of large bowel are in the left. Figure 17 indicates that the jejunum-ileum instead of rotating counter-clockwise about the superior mesenteric artery as an axis, rotates clockwise and invaginates the primitive mesentery of the ascending and transverse colon (post arterial mesentery). When all the small bowel has invaginated this mesentery (Figs. 20 and 21) the duodenum of necessity crosses anterior to the trunk of the

superior mesenteric artery and not posterior to it, as would be the case were small bowel rotation normal and therefore counter-clockwise (Fig. 10). The drawings (Figs. 16 to 23) indicate the manner in which the small bowel invaginates the post-arterial mesentery until all of the small bowel is in the mesentery as if in a sac.

No case of hernia into the descending mesocolon possibly can arise in this manner because the sac formed by the ascending mesocolon separates the hernial contents from any contact with the descending mesocolon (Figs. 17 to 21). The descending colon and descending mesocolon in the instance of malrotation under discussion are entirely normal in development, rotation and posterior fixation.

A series of cross sections through this anomaly (Fig. 22) indicates how much the condition differs from that of hernia into the descending mesocolon (Fig. 27).

Proposed mechanism of development of hernia into the descending mesocolon. In the

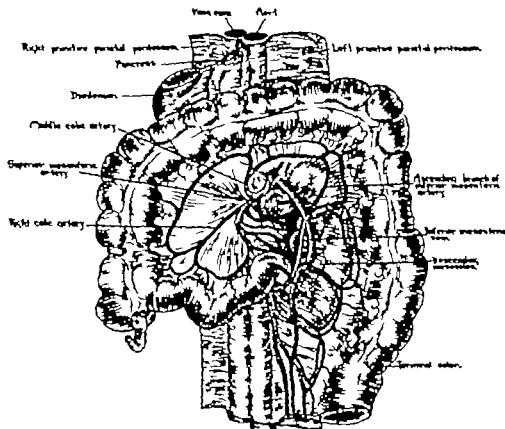


Fig. 25. Well advanced invagination of the as yet mobile descending mesocolon by coils of jejunum-ileum. It is evident that the sac is formed at the expense of the avascular area of descending mesocolon. Attention is drawn to the vascular trunks in the anterior wall of the neck of the sac.

development of a large hernia such as we are reporting we believe that a mechanism can be postulated which does not presuppose that the small bowel invaginate the periduodenal fossae, a fanciful theory in large ruptures. It seems logical that the loops of jejunum-ileum as they pass normally behind the superior mesenteric artery as in Figure 24 to Figure 26 invaginate the mobile descending mesocolon in its upper segment and within an area outlined by definite boundaries.

Before describing direct invagination of the descending mesocolon attention is called to Figure 23 which shows all the divisions of the large bowel and their continuous mesenteries lying unfixed. Their progressive changes of position to ultimate placement in the abdominal cavity is indicated numerically. Figure 14 indicates that the descending mesocolon has its root at the midline of the dorsal wall of the embryo. Between the leaves of the peritoneal duplication which forms the descending mesocolon the ascending branch of the left colic artery runs superiorly and somewhat laterally.

The inferior mesenteric vein also lies in the mesocolon and its main trunk is directed superiorly and mesially to combine with the superior mesenteric and splenic veins to form the portal vein. The artery and vein just mentioned usually run superiorly at some distance from the midline root of the mesocolon thereby leaving a very considerable avascular space between the ascending branch of the inferior mesenteric artery and the inferior mesenteric vein and the root of the descending mesocolon. This interval is indicated by an area of stippling. The closer to the descending colon these vessels lie the larger is the avascular interval of descending mesocolon.

It is our belief that in many cases of hernia into the descending mesocolon (so called left duodenal hernia) the upper jejunum and ileum in their migration to the left superior part of the abdominal cavity engage to a greater or lesser degree into the unsupported area of descending mesocolon just described. The mesocolon then falls to the left and fuses to the primitive posterior parietal peritoneum.

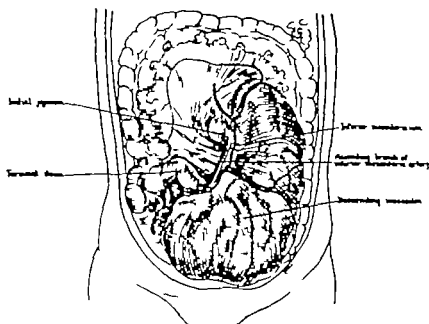


Fig. 26. Almost complete invagination of jejunum-ileum into descending mesocolon. This drawing represents the condition found in the case we are reporting. Compare it with Figure 1.

When the coils of small bowel invaginate the mesocolon the vascular trunks located in the left margin of the avascular area resist invagination. The result is that these trunks then lie in the forward wall of the neck of a sac all of which is derived from the avascular area of the descending mesocolon. Gradually all of the small bowel may enter the enlarging sac.

The series of changes resulting from the small bowel invagination of the descending mesocolon, while the mesocolon still is mobile, is illustrated in the series of cross sections in Figure 27. After all of the small bowel has entered the sac, the peritoneal surfaces outside the sac undergo fusion.

PLEA FOR A CHANGE IN NOMENCLATURE IN SO CALLED DUODENAL HERNIA

It must be evident that the duodenum with the occasional exception of its terminal portion is not an element in the hernial contents of the so called duodenal or paraduodenal hernia. Nor does the duodenum figure in any of the other varieties of so called duodenal hernia. It is the jejunum and ileum which are the contents of the sac. Inasmuch as part or

all of the small bowel invaginates the descending mesocolon in the type of hernia under discussion it is proposed that the so called left duodenal types of rupture be known rather as hernia into the descending mesocolon.

In a succeeding paper reasons will be adduced to justify a change in the name of that variety of intraperitoneal hernia known as "right duodenal hernia" to hernia behind the ascending mesocolon." The anomalous rotation of the jejunum-ileum reported by Haymond and Dragstedt should not be classed with either of these varieties of intraperitoneal hernia to that we wish to ascribe the name of hernia into the ascending mesocolon.

SYMPTOMS AND SIGNS OF HERNIA INTO THE DESCENDING MESOCOLON

The hernia we have described caused no symptoms and produced no physical signs. Many herniae with a similar lack of clinical manifestation have been found in a course of laparotomy for other conditions and during routine autopsy examination.

When however obstruction occurs in the bowel incarcerated within the hernial sac, an exact diagnosis of this type of internal hernia

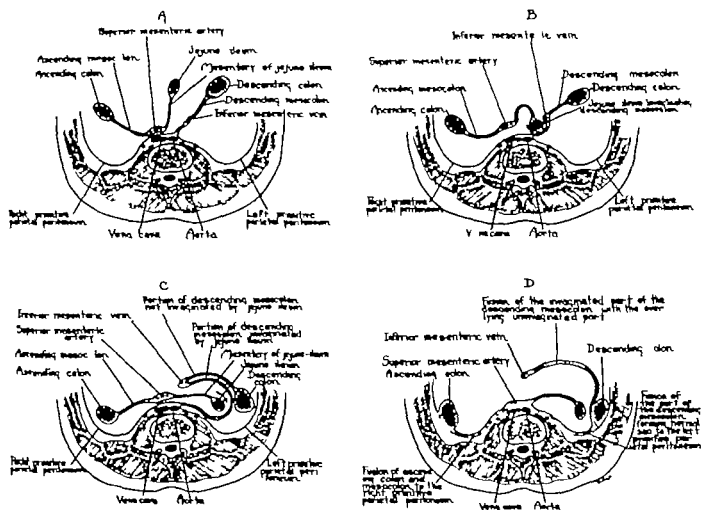


Fig. 27 Series of cross sections through region of development of hernia into descending mesocolon. A, In this section the jejunum-ileum and ascending colon are attached to a common mesentery and are mobile. The descending colon and mesocolon are mobile. Attention is drawn to the position of the inferior mesenteric vein in the descending colon. B The jejunum-ileum has begun to invaginate the avascular area of the descending mesocolon between the

inferior mesenteric vein and the midline attachment of the mesocolon. and a sac is in the process of formation. C, The jejunum-ileum has invaginated the avascular area of the descending mesocolon deeply and a larger sac is being formed. For clarity only one loop of small bowel is shown in the sac. D The opposed serous surfaces now fuse by the process of fetal agglutination. The colon and mesocolon now are fixed to the posterior abdominal wall.

sometimes has been, and in the future more often will be made. Considerable diagnostic importance should be placed upon the history of chronic intestinal obstruction. One in duvidual found to have this type of hernia suffered 40 different attacks of intestinal obstruction prior to the one which precipitated operation. If the signs and symptoms are only those of acute intestinal obstruction an exact diagnosis is difficult to make.

Certain signs sometimes are present which are of great value. A soft tumor in the left side of the abdomen several times has been found in the reported cases of hernia into the descending mesocolon but the swelling usually has been misdiagnosed as an ovarian or a

pancreatic cyst. The occurrence of one or more attacks of intestinal obstruction in addition to the presence of tumor should lead one to a consideration of the possibility of an intra peritoneal hernia.

At times the location and physical findings of the tumor are distinctive. Palpation may reveal the swelling as occupying the superior part or all of the left side of the abdomen. Percussion over the tumor should yield a resonant note, and the auscultatory findings may be those of gurgling peristalsis. The size and tension of the tumor mass and the degree of peristalsis depend upon the amount of obstruction in the incarcerated contents of the sac.

TREATMENT

The treatment of hernia into the descending mesocolon may be simple or extremely difficult. The operative results in the last 10 years have been much more favorable than those in earlier years—the consequence doubtless of more timely recognition of obstruction within the sac and earlier surgical intervention.

In several patients with small herniae, the incarcerated bowel was drawn out without difficulty into the general abdominal cavity through the neck of the sac, which was closed by suture. In occasional instances the serious condition of the patient has precluded the closing of the neck of the sac after withdrawal of its contents. On at least one occasion in a person so treated adhesions developed spontaneously about the orifice of the sac, and the hernia did not recur. In some herniae even of small size, manual reduction could not be accomplished under these circumstances. It might have been possible to loosen the neck of the sac by making a small incision in a superior and medial direction so that the vascular trunks in the forward walls of the neck could be avoided. It must be borne in mind constantly that the inferior mesenteric vein lies not only in the lateral margin of the neck of the sac but often courses medially in its superior portions in such a way as to preclude any incision in the neck of the sac.

In a very large hernia in which nearly all the jejunum-ileum lies within the hernial sac, the sac orifice usually is so constricted that the contents of the sac cannot be brought into the general abdominal cavity even when no adhesions at the neck of the sac are present. In the case we are describing the neck of the sac was small and the adhesions about it were so adherent that painstaking blunt, and sharp dissection were required to locate it. Had intestinal obstruction within the sac occurred, it would not have been possible, because of these adhesions, to have delivered the hernial contents into the general abdominal cavity. The only possible recourse in the treatment of such a situation would have been incision of the anterior wall of the sac (descending mesocolon) in an avascular area and the emptying of the dilated bowel by temporary enterostomy. After ascertaining and relieving the cause of

the obstruction the rent in the anterior wall of the sac should be closed.

SUMMARY

1 An instance is reported of herniation of practically all of the jejunum-ileum into the descending mesocolon (so called "left duodenal hernia").

2 The embryologic background of intestinal rotation and posterior peritoneal fixation is portrayed in order that the varieties of mechanism of production of this type of hernia can be understood.

3 A detailed description of the folds and fossae about the terminal duodenum is given so that the rôle they play in the production of this hernia may be interpreted properly.

4 In this paper it is suggested that hernia into the descending mesocolon occurs as a result of invagination of an area of the descending mesocolon by the jejunum-ileum while the descending mesocolon is mobile. A location in the descending mesocolon for the reception of the invaginating jejunum-ileum is indicated.

5 A change in nomenclature for the so called "left duodenal" type of intraperitoneal hernia is advocated. From the embryologic and anatomic viewpoints, this hernia should be known as a hernia into the descending mesocolon.

6 The salient features in the recognition and treatment of hernia into the descending mesocolon are enumerated.

We are indebted to Dr. John B. de C. M. Saunders for his constructive criticism and suggestions in relation to the embryological discussion in this paper.

BIBLIOGRAPHY

- 1 ANDREWS, EDWARD. Left duodenal hernia. *American Surg. Gynec. & Obst.* 1915, 37:740.
- 2 BRODERICK, GUYTON. Ueber Intraabdominelle (retro-peritoneale) Hernien und Bauchfelltraumen. *Beih. Fischer* 1891.
- 3 DOTT, NORMAN M. Anomalies of intestinal rotation: their embryology and surgical aspects, with report of five cases. *Brit. J. Surg.* 1923-24, 11:251.
- 4 EPPINGER, HANS. Hernia Retro-Peritonealis. *Verh. Jahrbuch f. d. pract. Heilk.* 1870, 4:181.
- 5 HAYMOND, H. E. and DRACUTZ, R. Anomalies of intestinal rotation: a review of the literature and report of two cases. *Surg. Gynec. & Obst.* 1931, 53:316.
- 6 LAMBERT, T. Ueber die Hernia Retro-Peritonealis. *Beitr. z. Anat. u. Histol.* St. Petersburg, 1872, of 1.
- 7 MOTTENHAY, B. G. A. On retro-peritoneal hernia. New York: Wm. Wood & Co. 1908.

8. SPOHR, A. R. On retroperitoneal hernia with a report of the literature. Brit. J Surg. 1924-1925 12:456
9. TOLDE, KARL. Bau- und Wachstungsverhältnisse der Gekröse des menschlichen Darmkanals. Denkschr d. k. Akad. d. Wissensch. z. Wien Math. Naturw. Classe, 1879, 41: Feb
10. Idem. Die Darmgekröse und Netze im Gesetzmässigen und Gesetzwidrigen Zustand. Denkschr d. k. Akad. d. Wissensch. z. Wien. Math. Naturw. Classe, 1889, vo 56
11. TAYLOR, WINCESLAUS. Hernia Retro-Peritonealis, ein Beitrag zur Geschichte Innerer Hernien. Prague F. A. Credner 1837
12. WALDEYER, HENRICUS G. G. Hernia Retroperitonealis nebst Bemerkungen zur Anatomie des Peritoneum. Breslau 1868.

THE USE OF VITAL STAINING AND WET FILMS IN THE DIAGNOSIS OF LESIONS OF THE CERVIX

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THE introduction by Schiller of a new and simple test for establishing the diagnosis of carcinoma of the cervix was of such interest and importance that the method has been tried at St. Thomas's Hospital upon a representative series of cervical lesions.

In the original paper Schiller pointed out that cancer of the cervix starts in the squamous epithelium in the vicinity of the os and spreads laterally and superficially from this point. The earliest changes consist of a proliferation of the squamous cells and the surface remains intact for some time before ulceration occurs. To locate these early patches of new growth a method of vital staining which differentiates normal from malignant epithelial cells was devised and small portions of suspicious material were removed for microscopy. As regards this method of vital staining it was pointed out that the normal squamous cells of the cervix contain granules of glycogen and that these granules could be stained vitally with Lugol's iodine. Schiller also stated that in some pathological conditions, and notably in early cases of carcinoma when the surface had not ulcerated glycogen was absent from the squamous cells and vital staining did not occur. He claimed therefore, that by using Lugol's solution it is possible to make a diagnosis of carcinoma earlier than by the usual clinical means.

Since the publication of this work in SURGERY GYNECOLOGY AND OBSTETRICS, several other investigators, particularly Graves and Frank, have endorsed these views and have stated that they are very much impressed by the value and possibilities of the method. Our own opinions are not in entire agreement with those which have been recorded by others, and the object of this paper is to state the value of vital staining as applied to lesions of the cer-

vix in general the drawbacks and difficulties in cases of carcinoma and to advocate the use of 'wet films' for the immediate investigation of pieces of tissue removed for biopsy.

The cases we have examined have practically all attended the Out Patient Department, and include normal cervixes, erosions, ectropion of the canal, extrusion of the mucosa, polypi traumatic conditions, and carcinomata both of the cervical canal and vaginal cervix.

The technique we have adopted is as follows. A speculum is passed after bimanual examination has been done, and the cervix is examined macroscopically. Mucus or other secretion is carefully wiped away and the surface of the cervix and vaginal vault is painted with Lugol's solution. The excess of iodine is sponged away and the reaction of the parts noted. In every instance small pieces of tissue from suspicious areas are removed and from these wet films are made immediately. The preparation of these films will be discussed subsequently.

The material for biopsy was obtained by a special punch¹ which we recommend to any who may wish to secure such material easily without causing inconvenience to the patient. Small pieces can be removed from the cervix without pain, even in cases of cervicitis, and on only one occasion have we had any trouble from bleeding.

Clinically our cases fall into three main groups when judged by the reaction of the cells to the vital stain.

In the first group are those in which the cervix and vaginal vault stain diffusely evenly and deeply. The reaction occurs almost as soon as the solution has been applied. This is the reaction of the normal cervix and apart from certain qualifications is fairly constant.

Made by Messrs. Allen and Hanbury to our order.

The depth of the stain varies to some extent with the age of the patient, and in the light of the work of Cruickshank and Sharman this is not surprising, for they have demonstrated that the glycogen content of the epithelium steadily diminishes after the menopause until in extreme old age it is very difficult to find any glycogen in the cells at all. This fact must be important in interpreting results of vital staining in old people. Again there are many cervixes which show clinical evidence of tears and cervicitis which stain in the normal way and finally it must be remembered that since the columnar epithelium of the cervical canal does not contain glycogen there will be a ring of unstained tissue round the os in cases suffering from ectropion of the mucosa.

The second, and perhaps the most common group of cases is those in which the cervix presents a mottled appearance due to patches of light brown or lemon yellow color among the normal dark stain. A peculiar feature of these patches is that they do not correspond to clinical lesions which are apparent macroscopically, on several occasions we have noted these patches in what we had judged to be a normal cervix. One is therefore forced to the conclusion that other factors influence vital staining apart from pathological conditions. The mottled cervix is most often seen in cases of erosion polypoid conditions cervicitis and in carcinomata which have ulcerated. It has been pointed out by other observers that pus on the surface of a lesion stains brown or black with the iodine and it is important not to overlook cases of early malignant ulceration when obscured in this manner. In our series we have seen only one case of carcinoma in which the surface of the growth had not ulcerated and this was a patient who was pregnant and who was found to have an early polypoid growth involving the posterior lip of the cervix. Lugol's iodine gave a mottled appearance and we were in doubt as to the correct diagnosis until the wet film had been examined. Sections made from the tissue removed confirmed the diagnosis and the tumor proved to be a squamous cell carcinoma. This case supports the view which has been expressed by others that is that pregnancy may interfere with the test.

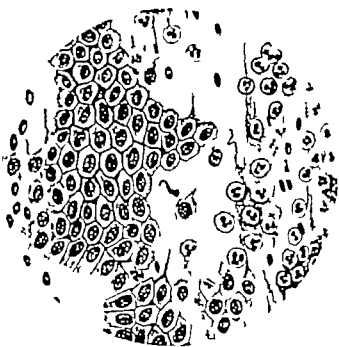


Fig. 1. Film showing plaque of normal cervical mucosa and acute polymorphonuclear inflammation. The regularity of the nuclei, the presence of cell membranes between the individual cells, and the even staining are the features which indicate the benign nature of this epithelium. $\times 330$.

The third clinical group is those in which there are absolutely white and unstained areas and we consider that the distinction between this complete absence of staining and the lightly stained areas in the mottled cervixes described has not been sufficiently emphasized. In these areas the cells are not even colored light brown by the iodine and they stand out in marked contrast to the dark brown of the vital stain. These areas according to Schiller indicate—

- 1 The presence of carcinomatous layers or incipient cancer
- 2 The presence of hyperkeratosis, a result of prolapse
- 3 The presence of hyperkeratosis of luetic origin
- 4 Desquamation of the superficial layers of the epithelium by trauma

In our series we have found that the lesions mentioned in this list are more frequently associated with a mottled or light staining and those in which we have found white patches have been fungating carcinomata areas of trauma which extended deeper than the epithelial layer, and occasionally in old scars and fibrous lesions.



Fig. 2. Normal squamous epithelium showing the gradual change from the basal layers to the superficial decussating cells on the surface. $\times 75$

Considering these results as a whole they show that the staining properties of Lugol's iodine are inconstant and difficult to interpret and are influenced by factors apart from pathological lesions. When it is remembered that cases of cancer of the cervix in the pre-ulcerative state are rare and that normal staining of the cervix does not exclude a carcinoma low down in the cervical canal it becomes obvious that vital staining is not as valuable a method of investigation as appears at first sight. Indeed we have come to the conclusion after careful trial of the method that visual and manual examination supplemented in difficult or doubtful cases by a wet film is the most likely to give an accurate picture of the various conditions we have treated.

Wet films are of use in this type of work because it is possible to give a diagnosis in the Out Patient Department while the patient waits, 10 minutes is all that is required in an urgent case, and because experience of this technique which has been in use at St Thomas's Hospital during the last 8 years has convinced us that in the hands of those who have studied the question the interpretation of films is accurate and reliable their preparation is simple, and the materials required are

available in any pathological laboratory. The reader is referred to papers (2, 3, 7) which have been published on this subject for they will serve as a guide to the technique of preparing wet films and the descriptions of preparations made from pathological conditions of all kinds elsewhere in the body give an idea of the value and limitations of the method. We have made wet films from every case in our series and a definite diagnosis has always been possible even in those instances where the staining of the cervix by Lugol's solution has been difficult to interpret or even deceptive.

The tissue removed with the punch must be teased out upon the slide before it dries, for the appearance of the cells alters rapidly if the tissue be kept for any length of time and it is essential that saline, preservatives, or other fluids are not used as diagnosis is not possible if autolysis has occurred. Sometimes it is difficult to make a good film from these cases because the piece of tissue available is small and may be very fibrous the best results are obtained by fixing it on the slide with a mounted needle and then teasing it with a scalpel which should have a broad blade. If the method is used in conjunction with Schiller's technique, as we have done it will be found that the epithelium which has taken the vital stain is decolonized at once by the Schaudinn's solution and consequently the iodine does not affect the subsequent staining with haemalum and eosin.

In order to interpret wet films made from the cervix it is necessary to have a knowledge of the normal histology of the part and the changes to which the cells are liable in health and disease.

In the normal cervix the junction of the squamous and the columnar epithelia is sharply defined and lies at the margin of the external os. The columnar cells vary in number and appearance not only with the age of the patient but also according to the stage of the menstrual cycle. It is usual to find them distended with mucus in vacuoles this can be confirmed by staining with muci-carmin. On the surface the epithelium is more regular and less distorted with globules of secretion than in the deep glands, and in old age the number of cells is diminished and the glands may be



Fig 3. Carcinoma of cervix. The plaque of epithelial cells in this film shows irregularity in the size and shape of the nuclei, an absence of cell membranes between the individual cells, and a tendency of the nuclei to separate from each other. Compare this film with Figure 1. $\times 280$



Fig 4. Carcinoma of cervix. The malignant cells are completely separated from each other. The nuclei vary enormously in size and shape. There are some mitotic figures and there is evidence of diffuse polymorphonuclear inflammation. $\times 280$

absent. The squamous epithelium of the adult is similar to that elsewhere in the body consisting of a basal layer, a zone of prickly cells and a mass of desquamating cells on the surface. In films the granules of glycogen cannot be seen, but in sections fixed in absolute alcohol and stained by Best's technique they are found easily and are scarlet. They are concentrated for the most part in the deeper layers of the epithelium.

The height and depth of the squamous epithelium vary in health and are not necessarily connected with pathological conditions; they bear a close relationship to the glycogen the cells contain, and this is dependent upon ovarian activity.

The epithelial cells rest upon a stroma composed of spindle cells and small blood vessels.

In films the various epithelial elements and the stroma are seen and the differences which occur in the normal cervix must not be forgotten.

The columnar cells in the film are found either in plaques resembling a tessellated pavement, or as a typical row of epithelial cells with an even round nucleus at the base of each cell. The mucus in these cells causes

variation in their size and shape but the regularity of the nuclei and the definite cell membrane are the features upon which the diagnosis of benign epithelium is made. Separation of the cells tends to occur if there is much mucus.

The squamous epithelium nearly always separates into two parts: the superficial desquamating cells break away in plaques from the prickly cells and basal layer and these plaques stain pink, whereas the deeper cells take up haemalum strongly and are blue. In the presence of acute inflammation it is not unusual for the squamous and columnar cells to be phagocytic and we have several films showing these cells engulfing polymorphonuclear cells. If this occurs the cells are much larger than normal, but the enlargement is confined to the cytoplasm and the nuclei remain small and regular.

The stroma is represented by groups of fibroblasts and by isolated spindle cells. In cases of cervicitis there are areas of granulation tissue and polymorphonuclear leucocytes are plentiful. It is occasionally possible to demonstrate capillaries in films made from granulation tissue.

The main application of this method is to distinguish between inflammatory and neoplastic conditions. We have noticed that almost every cervix we have examined has shown a marked degree of polymorphonuclear infiltration. This inflammation does not necessarily produce pain or symptoms, but is probably a cause of the excess of mucus secretion in chronic cervicitis. We have found inflammation not only in cases in which surface ulceration is present but in patients with an intact epithellum covering the cervix.

A diagnosis of carcinoma is made upon the appearance of the malignant cells themselves and does not depend upon infiltration of the neighboring tissues or the presence of metastases. The points upon which this diagnosis is made have been described fully elsewhere and the reader is referred particularly to the most recent paper on the subject in the *British Journal of Surgery* (2).

In recommending wet films as an aid to the diagnosis of lesions of the cervix, we desire to thank Professor Dudgeon who with C. V. Patrick introduced this method in 1927 and has helped us by examining the majority of the films we have made.

REFERENCES

1. CRUCKERHANK, R. and SHARMAN, A. The biology of the vagina in the human subject. *J. Obst. & Gynec. Brit. Emp.* 1934, 41, 2.
2. DUDGEON, L. S. and BARRETT, V. R. The examination of fresh tissues by the wet-film method. *Brit. J. Surg.* 1934, 21, 85.
3. DUDGEON, L. S. and PATRICK, C. V. A new method for the rapid microscopical diagnosis of tumours, with an account of 200 cases so examined. *Brit. J. Surg.* 1927, 5, 50.
4. FRANK, L. Carcinoma of the cervix uteri. *Am. J. Surg.* 1934, 22, 3.
5. GRAVER, W. P. *Surg. Gynec. & Obst.*, 1933, 56, 317.
6. SCHILLER, W. Early diagnosis of carcinoma of the cervix. *Surg. Gynec. & Obst.*, 1933, 56, 210.
7. WHITLEY, A. J. A new method of rapid diagnosis of pathological specimens. *J. Obst. & Gynec. Brit. Emp.* 1932, 34, 527.

STUDIES ON PERIPHERAL VASCULAR PHENOMENA

IV FINGER VOLUME CHANGES IN A PATIENT SHOWING RAYNAUD'S PHENOMENA

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EVER since Raynaud (5) described the clinical entity carrying his name, this disease has been the subject of a great deal of study.

We wish to present a case upon which special studies were made that may throw more light upon the basis of the peripheral vascular phenomena which occur in this obscure disease.

REPORT OF CASE

Mrs I, 37 years old, consulted one of us (Hedges) in November 1933 for stiffness of the fingers. Her chief complaints were inability to play the piano and some pain and stiffness of the toes, when she walked. Mrs I states she had iritis of right eye in 1929 and following this her right ankle and wrist became swollen and tender. A diagnosis of arthritis was made and she had some teeth removed and a tonsillectomy performed. The arthritis subsided but she soon began to experience some stiffness of the fingers of both hands. No attention was paid to this condition until about April, 1933 when Mrs I was forced to stop playing the piano.

Previous to the above history patient had enjoyed good health. Her husband died suddenly in 1933 of septicemia. The family history was negative. There was no history of malaria. Physical examination is briefly as follows: height 5 feet, 6 inches; weight 147 pounds; blood pressure—right arm 110/68; left arm 94/68; pulse 88.

Color of both hands was poor—dusky color. The skin was tense over the fingers, especially of the right hand. The first and second fingers of right hand were stubby but did not show a true clubbing. The hands were cold. She was unable to flex the fingers of either hand, especially the right hand. There was no muscular atrophy of the arms. The hands appeared small and perspired freely in palms. Some slight nutritional disturbance of finger nails was present. Pain was present across the knuckles when hand was pressed. There was a thickening of the skin of the ventral surface of the hands. There was a definite line of demarcation just distal to the middle joint of the fingers of both hands on immersion in cold water. This pallor remained for about 3 minutes and was replaced by cyanosis (Fig. 1). There was no disassociation of heat and cold sense on either arm or hand.

The lower extremities were practically normal although there was some slight enlargement of the

joints present. The blood was normal with the exception of a slight anemia—3,900,000 red blood cells. The urine was negative, no Bence Jones protein present. Blood chemistry analysis: normal calcium 9 milligrams per cent; phosphorus, 2.8 milligrams per cent. The blood viscosity was normal. The electrocardiogram was normal.

Roentgenograms were made of both hands (Fig. 2).

One showed considerable loss of distal phalanges especially of the right hand.

Roentgenograms of the feet showed no such destruction of bone. There was no cervical rib present and X-ray examination of the long bones, head and pelvis showed no systemic bone involvement.

Studies on the peripheral circulation were made with a special device previously described by Johnson. This device measures the finger volume change associated with the heart beat. Skin temperature changes were made with the ordinary thermocouple and color changes were observed by comparison with the color charts as devised by Lewis.

The finger volume changes at room temperature were uniformly lower than usually observed in the normal human being. Also the skin temperature was uniformly lower than observed in the normal (Figs. 3, 4, 5).

Immersion of the hands in hot water (45 degrees C for 10 minutes) caused a moderate increase in the finger volume changes (Fig. 3).

Immersion of the hands in cold water (10 degrees C) caused a reactive hyperemia associated with increased finger volume changes without cyanosis.

Occasionally it was possible to induce a spasm of the peripheral vessels by immersion of the hand in moderately cold water (between 13 degrees and 18 degrees C). Associated with this the fingers assumed the color changes characteristic of Raynaud's phenomenon. This is in keeping with the observations of Lewis, that the optimum temperatures for inducing a spasm lie between 13 and 18 degrees C.

The color changes of Raynaud's phenomenon were most easily induced by having the patient go out of doors and expose her hands to moderately cold air and Figure 4 shows graphically the changes which occur during the spasm. It is shown by these charts that even in the very cyanotic stage the finger volume changes were greater than the control and subsided to a very low level in about an hour. As will be seen from the charts the skin temperature did not bear uniform relationship to the color changes or the finger volume changes in this particular case.



Fig. Photograph of the patient's hands during an attack. Note the cyanosis of the fingers of the right hand up to the first interphalangeal joints. The ends of the fingers are stubby but a true chelbing is not present. This is particularly true in the right hand where the absorption of the terminal phalanges is most marked (see Fig. 2).

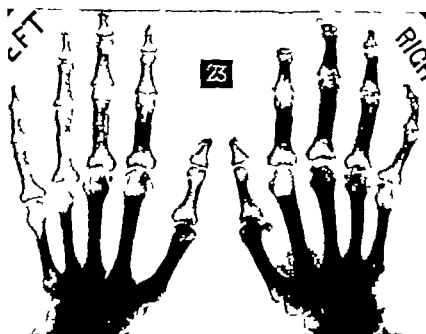


Fig. 2. Roentgenograms of the bones of both hands showing the absorption of some of the terminal phalanges. This is most marked on the right.

Treatment. This patient was given tissue extract because it was supposed to cause vasodilatation, but it has been shown by Roth and Barber not to exert its effect by vasodilatation. These authors think that its action is directly on the muscles supplying a deficiency due to inadequate blood flow.

The result was not very satisfactory in this case, although, if a spasm was induced by exposing the hands to cold air, tissue extract would cause a color change, i.e. from cyanosis to a more normal color.

After several months treatment with tissue ex-

tract, Mrs. I. noticed improvement in her ability to move the hands. No noticeable improvement was noted in the scleroderma. The vascular spasms were of about the same intensity at the termination of treatment and about the same duration. The tissue extract would cause a color change lasting about 2 hours. Figure 5 shows the results upon the skin temperature, color and peripheral pulse volume. There was improvement in the colors of the fingers of the right hand but no increase in the pulse volume changes. From this result it would be difficult to

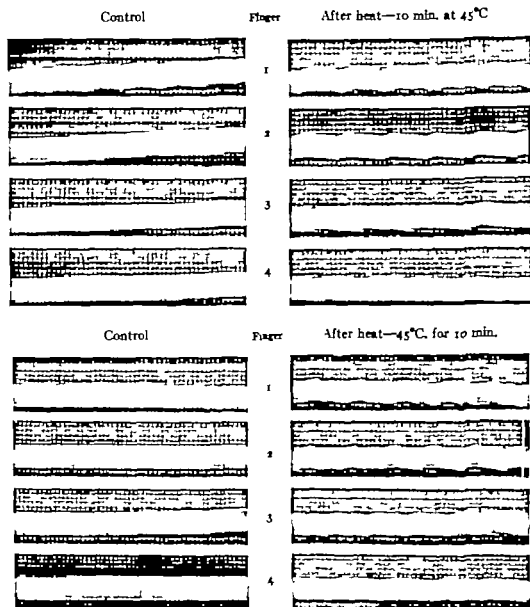


Fig. 3 The finger volume changes of the fingers before and after the application of local heat. (Immersion of the hand in water at 45 degrees C for 10 minutes). The upper record shows records from the fingers of the right hand and the lower are the left. Note the very low amplitude in the control records indicating that under normal environmental conditions the circulation is less than normal. The local heat relaxes the peripheral vessels and allows for an improved circulation.

draw any conclusions regarding the value of this medication.¹

The classification of this case as one of Raynaud's disease is open to some question because as Lewis states 'Thus it is quite possible that patients who in the first instance display attacks of cyanotic fingers and subsequently acquire a general scleroderma are essentially of the same type, but as we have yet

¹Later experiments have shown that it is possible to demonstrate a vasodilatation, as evidenced by increased finger volume changes, by using larger doses of lumps extract and waiting a longer period. The maximum change occurs in about 34 hour and the effect wears off in about 1 to 2 hours, depending upon the dose.

no proof that the vessels in these cases respond directly and unusually to temperature and as we do not understand how the general scleroderma occurs it is quite clearly desirable that this class of case should be kept apart until it has been submitted to suitable investigation' (4). On the other hand, we think this case would fall into group 2 of the 204 cases of Raynaud's disease as reported by Allen and Brown (1). Kolodny (3) reported a case with symptoms and X ray findings similar to the one we have described who received con

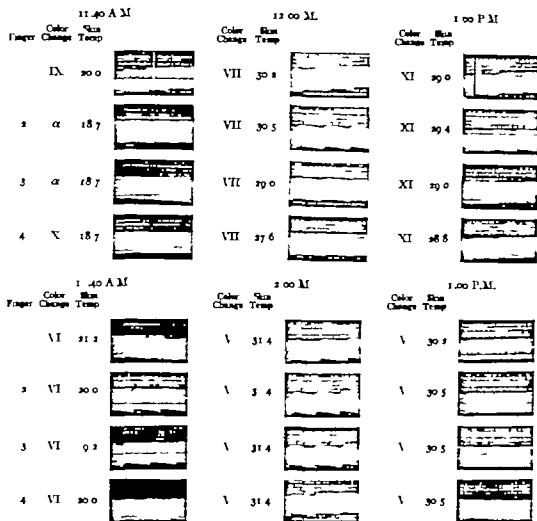


Fig. 4. The finger volume changes in the fingers of both hands just following vascular spasm. The upper record as the right side and the lower the left. The skin temperatures are shown and the Roman numerals and letters represent the colors of the fingers as compared with the color charts devised by Lewis. Note that in the cyanotic stage the fingers become warm and the pulse volume changes are increased indicating an increased circulation. This subsides in about an hour to a very low level, but the skin temperature changes lag considerably behind this change.

siderable relief from a cervical ganglionectomy and ramisection. We consider our case one of Raynaud's disease complicated with scleroderma and sclerodactylia.

The symptoms in our patient are quite characteristic of Raynaud's disease.

There is a long history of rather painless attacks of cyanosis of the fingers up to the first interphalangeal joints (Fig. 1). The disease is symmetrical, i.e., it involves the fingers of both hands and also less severely the toes of both feet. The attacks are initiated most

easily by moderate cold such as temperatures between 13 and 18 degrees C. An attack is more easily initiated by exposure to cool air than by immersion of the hand in cold water. As was the case with most of Lewis's patients the phenomena of pallor did not occur but the fingers became cyanotic or violet and as recovery took place became red and finally assumed their usual color.

The plethysmographic studies lend support to the diagnosis of Raynaud's disease. The pulse volume tracings in the absence of an


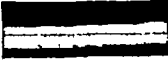


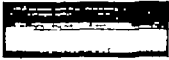
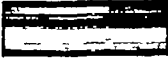


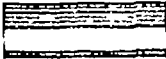
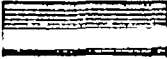

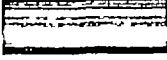

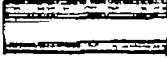
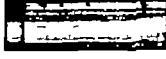
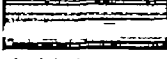
Color Change	Skin Temp.	Control	Finger	10 min. after tissue ext.	Skin Temp	Color Change
VIII	23.5		1		25.0	V
VII	25.0		2		25.5	V
VII	25.0		3		25.0	V
IX	25.0		4		24.5	VI
Color Change	Skin Temp.	Control	Finger	10 min. after tissue ext.	Skin Temp	Color Change
V	25.5		1		25.5	V
V	25.5		2		25.5	V
V	25.5		3		25.5	V
V	25.5		4		25.0	V

Fig. 5 The effect of tissue extract on the peripheral circulation, temperature and color changes. The skin temperatures did not change but there was an improvement in the color of the right hand, above. There was no improved circulation following this medication.

attack were uniformly lower than in normal individuals indicating a large vasospastic element (Figs 3, 4, 5). This could be relieved by immersion of the hand in hot water (Fig. 3). When an attack occurred and the blue color appeared the skin temperature rose rapidly and the pulse volume changes increased. As the attack subsided the pulse volume changes decreased to a subnormal level but the skin temperature did not parallel these.

Operation with a cervical ganglionectomy and ramisectomy was advised, but the patient refused. It was felt that the interference with the heat regulating mechanism of the upper

extremities as evidenced by the increased skin temperatures following this operation would render her less liable to attacks.

SUMMARY AND CONCLUSIONS

We have presented a case of Raynaud's disease complicated with scleroderma and sclerodactylia.

Circulatory studies were made with a special finger plethysmograph which indicate that in this case the peripheral circulatory changes were as follows:

1 The circulation was persistently less than normal in the fingers even in the absence of an attack.

2 A peripheral vasodilatation could be induced with local heat.

3 During the cyanotic stage of Raynaud's phenomenon the circulation was increased

4 Tissue extract improved the color of the fingers, but did not induce vasodilatation

REFERENCES

1. ALLEY E V and BROWN G E. J Am M Ass 1932, 99 1473
2. JONESBROOK, CARL A. Surg. Gynec. & Obst., 1932, 55 731.
3. KOLONNY ANATOLE. J Am M Ass 1930, 93 1 20
4. LEWIS, THOMAS. Heart, 1929, 15 No. 1
5. RAYNAUD MAURICE. L'Asphyxie locale et de la Gange symétrique des Extrémités. Paris, 302
6. ROTR, GRACE M., and BARBER, V. W. Proc. Mayo Staff Meet M J Clin 1934, 9 390

ELECTROSURGICAL ASEPTIC INTESTINAL ANASTOMOSIS¹

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ELECTROSURGICAL methods as applied to the hollow viscera are still in the experimental and very early practical clinical stages and further studies are imperative before their actual value can be established. With this in mind we have performed several different types of aseptic intestinal anastomosis experimentally and have applied the procedure clinically in man.

This paper is a presentation of the experimental technique used the surgical pathologic physiology of the procedures and the suggestions of their clinical application in man.

Ward (2) at Kelly's suggestion performed anastomosis by electrocoagulation as follows:

The loops to be joined were grasped with the usual anastomosis clamps drawn together parallel. Two layers of Lambert suture were used to approximate the posterior walls of the proposed stoma. In lieu of making an opening into the lumen of the loops, the intended sites of opening were coagulated by inserting a needle electrode carrying a biterminal current down to but not through the mucosa, relying on the coagulation at the tip of the needle to destroy the mucosa also. The needle not piercing the mucosa, obviated any immediate contamination from the bowel lumen. The two anterior layers of sutures were then laid, completing the operation. In from 24 to 48 hours, the coagulated tissue sloughed through and completed the anastomosis. The technique was fairly satisfactory in the intestinal anastomosis but was not to be relied upon in the stomach with its redundant mucosa which was coagulated ineffectually. We have not yet tried this procedure on man and feel that it is not applicable where there is an immediate need of an anastomosis.

Briggs (J E) and Whitaker (L R) later reported similar experiments performed independently of Ward's. Their technique calls for only one row of sutures to avoid leakage, as the delayed opening

allows thorough sealing of the edges of the anastomosis by the fibrinous exudate before there is any chance for contamination.

In an effort to perfect an aseptic anastomosis technique that would immediately open the loops at operation, W W Walker devised a small hollow wooden instrument (Fig. 158) about the diameter of a lead pencil and 2 inches long. A groove was cut on each side, through which two pointed prongs could move from one end to the other by means of a stiff wire extending out of the end of the instrument. At operation, the posterior sutures were laid first, the instrument being placed between the loops so that the sharp prongs would each pierce the wall of one loop. The anterior sutures then closed the loops over the instrument. As a biterminal current was applied to the wire projecting from the end of the instrument, traction was made, drawing the prongs through the walls and cutting the tissues as they passed. On removing the instrument, the incisions were found to be open and dry, all vessels having been coagulated. The impractical feature of this instrument lies in the inability to remove it from between the loops of bowel in a completely aseptic fashion as at present constructed, it must be withdrawn from its position into the sterile field. At attempts have been made to obtain an insulating substance out of which a collapsible instrument could be constructed, which would fall within the lumen of the intestines and later be passed. The material out of which such an instrument is made must of necessity be sterilizable and capable of being worked up into a tiny device. These obstacles are technical and are being studied.

The following operations have been successfully performed by us experimentally: (1) gastro-enterostomy (2) cholecystgastrostomy (3) anastomosis of small intestine to small intestine (4) anastomosis of small intestine to large intestine (5) anastomosis of large intestine to large intestine (6) anastomosis of ureters to large intestine. On man we have

¹From the Service of the Third Surgical Division, Bellevue Hospital, New York University and Bellevue Hospital Medical College. Dr. Arthur M. Wright, Director, and Department of Experimental

successfully performed a side-to-side anastomosis in the large bowel

APPARATUS AND INSTRUMENTS

Any inexpensive apparatus carrying coagulating current which can be set to 1000 milliamperes and ranging to 1500 milliamperes can be used. We have employed an ordinary commercial model carrying the above range of coagulating current. To set the apparatus the milliammeter is connected to the diathermy pole and the spark gap advanced until the milliammeter registers 1000 milliamperes. The degree of spark gap advancement necessary to raise the coagulating current to 1500 milliamperes is then noted. The diathermy connection is transferred to the coagulation pole and the other connected to the indifferent electrode. Since 1000 milliamperes is the amount of current of choice the spark gap is reduced to that point in the apparatus.

This amount of current gives a slow even and penetrating coagulation without causing distant injury and avoids loss of control. The coagulated tissue first turns white 'parboiled' about the same color as the coagulated albumin of a hard boiled egg. If coagulation is continued further the 'parboiled' area turns a light grey, then a dark grey followed by charring. In ordinary work on the small and large bowel the light grey color is the optimum stage of coagulation. In doing work on thicker viscera as the pylorus and stomach a little darker grey is the optimum stage of coagulation. Therefore one can regulate quantitatively by increasing the milliamperage, the speed, and degree of coagulation.

The electrodes are the unipolar (Fig 1a) the bipolar (Fig 1b) and the multipolar (Fig 1c). The unipolar electrode consists of an ordinary non-cutting intestinal needle affixed to a holder and used in conjunction with an indifferent electrode which is placed under the patient to complete the circuit. While this electrode can be used for any type of work it is slow and tedious when long lines of coagulation are to be made. Therefore it is reserved for fine point coagulation as in performing operations on the gall bladder and ureters.

The bipolar electrode (Fig 1b) is the electrode used for electrocoagulation of tonsils

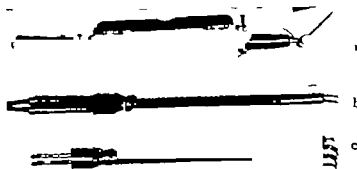


Fig 1: Electrodes a, Unipolar b, bipolar c multipolar

and sold commercially for that purpose. The points of the electrode are introduced through the serosa and embedded in the muscularis of the portion of the intestine to be coagulated and gives an area of coagulation 5 millimeters in circumference and through all the layers of the bowel. In doing work on the stomach or pylorus the needle points must be introduced deep into the muscularis to insure coagulation of the mucosa. One can readily see that by point-to-point coagulation linear circular etc. coagulation can be fashioned.

The multipolar electrode (Fig 1c) was devised by one of us and constructed at the university machine shop. It is in reality a six pronged bipolar electrode giving a line of coagulation 2.5 centimeters in length and through all the layers of the bowel. The same technique is employed as in the use of the bipolar electrode. Long lines of coagulation can be performed very quickly thus greatly reducing the time of the procedures.

TECHNIQUE

The general principle of the operation for aseptic intestinal anastomosis is illustrated in Figure 2. The loops to be anastomosed are approximated by a seroserous continuous suture of 20 day chromic No. 00 atraumatic, as is done in the first step of any conventional type of anastomosis (Fig 2a). With the bipolar or multipolar electrode two lines of coagulation are performed on what normally would be the lines of cautery incision in the conventional technique. The multipolar electrode is the instrument of choice attached to 1000 milliamperes coagulation current. The prongs are introduced through the serosa and into the muscularis. The coagulating points

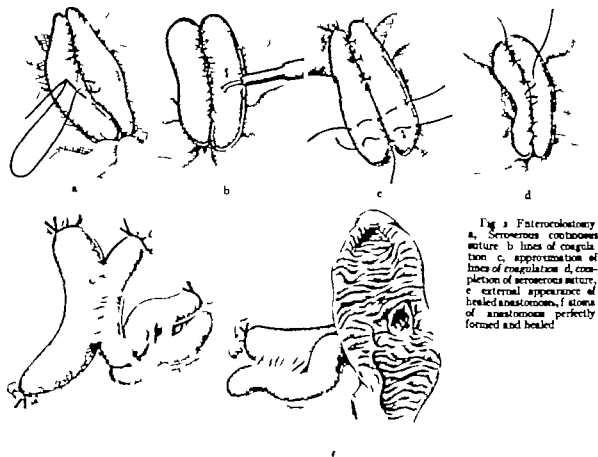


Fig. 1. Enterocolostomy. a, Seroseros cotuberos suture. b, lines of coagulation. c, approximation of lines of coagulation. d, completion of seroseros suture. e, external appearance of healed anastomosis. f, stoma of anastomosis perfectly formed and healed.

must enter 1 centimeter away from the seroseros suture line and must begin and end $1\frac{1}{4}$ centimeters proximal to the ends of the seroseros line of suture (Fig. 2b). The circuit is completed by means of a foot switch controlled by the operator. The area around the electrode gradually turns white, parboiled and becomes as hard as shoe leather and then turns light grey. When the white parboiled color appears, the area is carefully watched as it quickly turns to a light grey which represents the optimum point of coagulation. The foot switch is then released and the electrode advanced further to a new segment of the coagulation line until the two lines of coagulation are completed as shown in Figure 2b.

The two lines of coagulation are approximated by a series of two or more Lembert sutures of plain catgut as shown in Figure 2c placed $1\frac{1}{4}$ centimeters apart. The seroseros suture begun in step 1 (Fig. 2a) is now com-

pleted to bury the two apposed lines of coagulation (Fig. 2d).

In the first 24 hours there is an inflammatory reaction which completely seals the area between the lines of coagulation and the seroseros suture. When the suture begins to separate at the end of the 24 hour period no spillage can take place into the peritoneal cavity. Gas and liquid usually pass through in 36 hours and within 48 hours the anastomosis allows also solids to pass. In 7 days the anastomosis is completely formed and healed.

The animal made an uneventful recovery and the specimen obtained showed the complete external healing (Fig. 2e) and perfectly formed and healed anastomosis (Fig. 2f). It is of interest to note that this represents a successful anastomosis between the third portion of the duodenum and the ascending colon. These two loops were chosen because the anastomosis of these two loops represents the

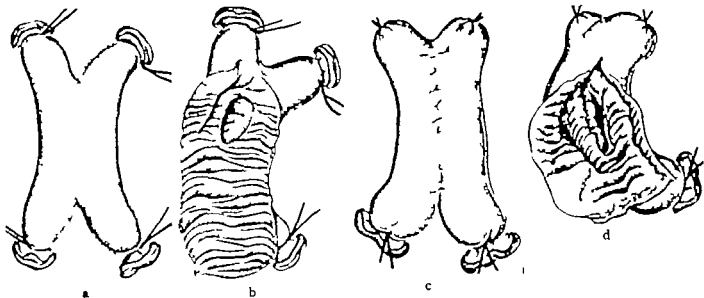


Fig. 3 Enter-enterostomy a, External appearance of healed anastomosis, b healed and functioning stoma c

healed external appearance of enter-enterostomy following intestinal resection d stoma healed and functioning

severest test that can be given any technique for anastomosis. Three controls in which the conventional suture methods were employed and the most scrupulous asepsis and technique were used all promptly died with infection and secondary leakage. One must remember the strong digestive power of the duodenal contents and the virulence of the faecal material to understand readily the poor results that are obtained by the use of the conventional method.

The final length of the completed anastomosis is usually two-thirds the length of the original line of coagulation. If a 2 inch anastomosis is desired as a final result the line of coagulation must be 3 inches in length. No special aseptic precautions are necessary; there is no spilling, no haemorrhage and the time for the operation is one third the amount used in doing the conventional type of operation.

Anastomosis of jejunum to ileum 2 weeks after operation is shown in Figure 3. This technique is most adaptable and successful in this type of anastomosis. Figure 3a demonstrates the perfectly healed serous surfaces and Figure 3b the perfectly formed healed and functioning anastomosis. As in all our experiments no pre-operative or postoperative special precautions as to diet etc. were taken in order to give the technique a severe test.

INTESTINAL RESECTION AND SIDE TO-SIDE ANASTOMOSIS

Twelve inches of ileum were resected and the ends of the resected bowel were inverted in the usual way. A side-to-side anastomosis was performed as shown in Figure 2. The dog never refused food and never had any symp-

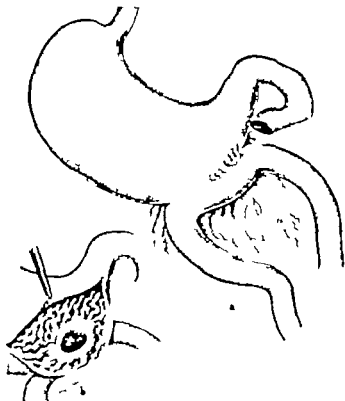


Fig. 4 Gastro-enterostomy a Healed external appearance of anastomosis b healed and functioning stoma

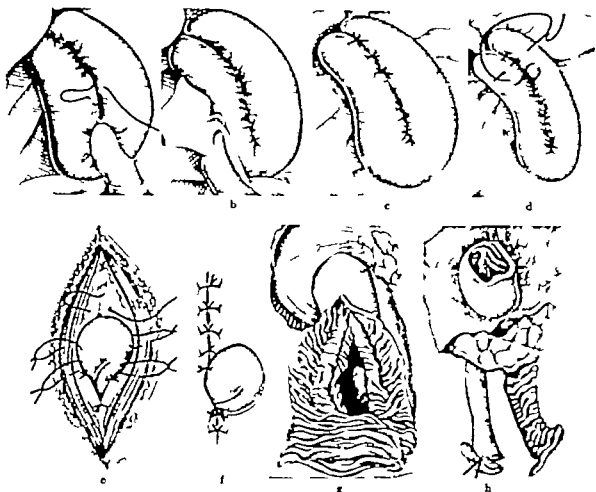


Fig. 5 a, Seroserosal suture line b, lines of coagulation, apposing the lines of coagulation, d, completion of seroserosal line of suture c, closure of abdomen and fixation

of colon to peritoneum, f, summit of colon coagulated, g, formed healed, and functioning stoma h, functioning colostomy



Fig. 6. Cholecystogastrostomy a, Healed external appearance is shown b, perfectly opened and functioning stoma looking into gall bladder c, functioning stoma in pylorus

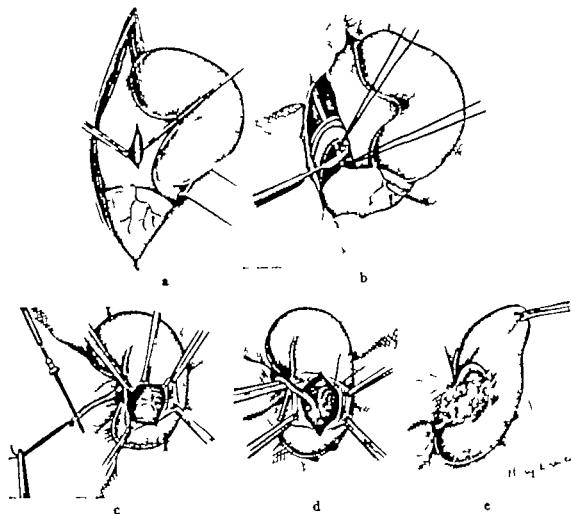
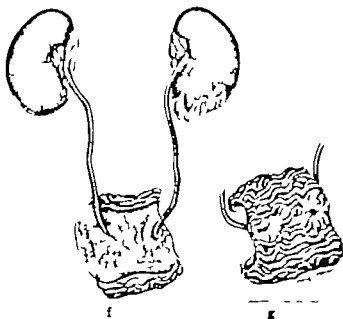


Fig 7 Ureterocolostomy a, Exposure of ureter sigmoid exposed, b, division of ureter with ligation of divided ends c, incision of sigmoid down to mucosa, coagulation of mucosa and ureter d, opposition of coagulated areas of ureter and colon e, suture of muscularis and serosa covered by omentum f external view of the anastomosis g, the functioning valve openings of ureters in sigmoid



toms or signs of intestinal obstruction. Four weeks after operation the dog was sacrificed and the perfectly formed and functioning anastomosis is shown in Figures 2 3c, and 3d

GASTRO-ENTEROSTOMY

The electrosurgical technique for this operation is identical to that for side to side anastomosis of the bowel. The multipolar elec

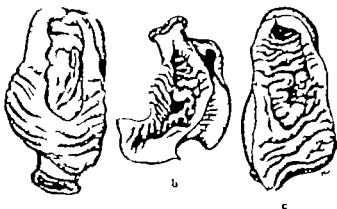


Fig 8. Gross surgical pathology. a, Twenty-four hour appearance of stomach, with slough ready to separate. b, 48 hours slough separated. c, slough completely separated with early healing of mucosa.

trode is used with its prongs inserted deep into the muscularis of the stomach and 1500 milliampere current is used. The line of coagulation must be grey in color. In performing the line of coagulation on the loop of small intestine 1000 milliampere current is used and the electrodes inserted as described in the previous operation.

The illustrations Figure 4 represent the results 10 days after operation of a gastrojejunostomy as performed on the dog. The dog was allowed the usual rations and purposely no special postoperative care was taken in order to give the operation the severest test possible. The animal made an uneventful recovery and did not miss a single meal.

Figure 4a represents the external appearance of the healed anastomosis and 4b the anastomosis opening perfectly formed functioning and well healed.

We do not agree with Ward that the redundant mucous membrane of the stomach prevents the use of this technique. Failure to coagulate the mucosa properly is only a technical one and if the electrode is introduced as directed and coagulation done to a grey color with 1500 milliampere current the mucous membrane will be properly coagulated.

This technique is not suggested to supplant the present technique by suture method. The operation has a place however when in repairing a ruptured duodenal ulcer a gastroenterostomy is necessary. If suturing the ulcer causes a too marked stricture and a gastroenterostomy is necessary, this technique should be used. The procedure is quick

ly done and does not expose the patient to spilling hæmorrhage or prolonged surgical technique. The anastomosis forms itself automatically while the ulcer surface is healing.

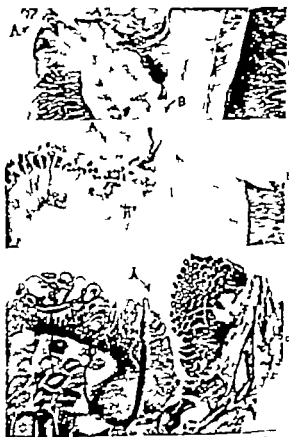


Fig 9. Microscopic surgical pathology. a, Twenty-four hours postoperatively, slough still attached. b, 48 hours after operation, slough almost entirely separated. c, 8 days after operation, mucosa entirely joined and healed.

ENTERO-ENTEROSTOMY OF LARGE BOWEL TO LARGE BOWEL

A 6 inch loop of descending colon was sutured together near the mesenteric attachment by a continuous seroserosus suture of 20 day No 00 chromic (Fig 5a). Two lines of coagulation with 1000 milliampere current and multipolar electrode were fashioned on each of the opposed loops as shown in Figure 5b. The lines of coagulation were opposed and sutured together by eight interrupted Lembert sutures of plain catgut No 0 as shown in Figure 5c. The seroserosus suture (Fig 5d) was then completed thus burying the line of coagulation. The colostomy was then sutured to the pentoneum and allowed to protrude from the skin wound. The summit of the colostomy was coagulated at one point with the bipolar electrode (Fig 5f) so that in 36 hours it opened spontaneously. After 48 hours the colostomy functioned perfectly externally and internally. On introduction of a finger the anastomosis was found to be perfectly functioning. The dog moved his bowels both by rectum and through the colostomy. Figure 5g represents the internal view of the anastomosis perfectly formed and healed. Figure 5h shows the functioning opening of the colostomy on the abdominal surface.

Every surgeon knows the scrupulous asepsis necessary not only in performing anastomosis of the large bowel on the human, but also in animals. The danger of infection, leakage, and peritonitis in the face of the virulent flora is very great. The procedure as above described is perfectly adequate and safe and eliminates the difficulty of maintaining asepsis since the bowel is not opened.

This type of colostomy and anastomosis suggests two new uses. The first is a large pouch colostomy. Instead of the centripetal loop only emptying itself as in the conventional colostomy, we have a large reservoir of both loops. The centrifugal loop is turned into a centripetal loop. The large pouch allows of less frequent movement of the bowel and might afford more cleanliness and comfort to the patient.

The second use is the performing of what normally is the second stage of a Mickulicz operation in the first stage of that procedure.

By the time the external colostomy is opened after the excision of the tumor, the internal anastomosis is already formed and functioning. This obviates the secondary clamping which is tedious and oftentimes difficult and unsatisfactory. We have performed such a procedure on the human with much success and gratification.

CASE REPORT

I L aged 56 years was admitted to Bellevue Hospital May 24, 1934, with a history of bloody stools, diarrhoea and pain in the left iliac region since January 1934. After a careful study including X rays a definite diagnosis of carcinoma of sigmoid at its junction with the descending colon was made.

At operation the mass was found and a Mickulicz operation done. A 4 inch side to-side anastomosis by electrocoagulation was performed just proximal to the mass as shown in Figure 5. Two days after operation a finger introduced through the colostomy opening revealed the anastomosis already formed and functioning. On the third day the patient had several small bowel movements by rectum and by the fourth day copious bowel movements.

In September 1934 she returned to clinic and examination revealed a healed colostomy wound and a perfectly functioning sigmoid with normal daily bowel movements and a gain of 25 pounds in weight.

CHOLECYSTGASTROSTOMY

In performing cholecystgastrostomy by electrocoagulation the pylorus was selected for the anastomosis. As the pylorus is extremely thick in the dog it offered an excellent test for the procedure.

The fundus of the gall bladder was sutured to the serosa of the pylorus transversely to its axis. Five millimeters away from this suture line and at its center the gall bladder was coagulated at one single point with the bipolar electrode piercing only the serosa. The 1000 milliampere current was used and the coagulation continued to a light grey color and 5 millimeters in circumference. At a point in the pylorus directly opposite to the point of coagulation on the gall bladder a 5 millimeter point of coagulation was performed. The bipolar electrode was used, introduced well through the muscularis. The coagulation was performed to a grey color and 1500 milliampere current was used. The areas of coagulation were opposed by two interrupted sutures of 20 day No 00 chromic catgut.

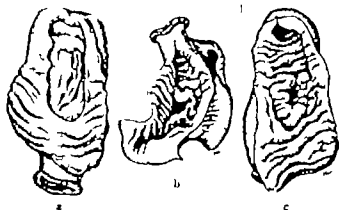


Fig 8 Gross surgical pathology a, Twenty-four hour appearance of stoma, with slough ready to separate b, 45 hours slough separated, c, slough completely separated with early healing of mucosa

trode is used with its prongs inserted deep into the muscularis of the stomach and 1500 milliamperes current is used. The line of coagulation must be grey in color. In performing the line of coagulation on the loop of small intestine 1000 milliamperes current is used and the electrodes inserted, as described in the previous operation.

The illustrations Figure 4 represent the results 10 days after operation of a gastrojejunostomy as performed on the dog. The dog was allowed the usual rations and purposely no special postoperative care was taken in order to give the operation the severest test possible. The animal made an uneventful recovery and did not miss a single meal.

Figure 4a represents the external appearance of the healed anastomosis and 4b the anastomosis opening perfectly formed functioning and well healed.

We do not agree with Ward that the redundant mucous membrane of the stomach prevents the use of this technique. Failure to coagulate the mucosa properly is only a technical one and if the electrode is introduced as directed and coagulation done to a grey color with 1500 milliamperes current, the mucous membrane will be properly coagulated.

This technique is not suggested to supplant the present technique by suture method. The operation has a place, however when in repairing a ruptured duodenal ulcer a gastroenterostomy is necessary. If suturing the ulcer causes a too marked stricture and a gastro-enterostomy is necessary this technique should be used. The procedure is quick

ly done and does not expose the patient to spilling hemorrhage, or prolonged surgical technique. The anastomosis forms itself automatically while the ulcer surface is healing.



Fig 9 Microscopic surgical pathology a, Twenty-four hours postoperatively, slough still attached, b, 45 hours after operation, slough almost entirely separated, c, 6 days after operation, mucosa entirely joined and healed

in place except at certain points in the periphery where gas and liquid material could filter through. Slight traction on the slough easily separates it from the points of attachment.

The hemorrhagic ring about the points of exit and entrance of the sutures in the serosa is rapidly disappearing in the 48 hour specimen. On division of the sutures and application of tension on the agglutinated seroserosus surfaces, it was found that they could still be separated but with much difficulty. No leakage could possibly occur at this stage of the healing process. The slough (Fig 8b) has completely separated with the exception of a few strands along the now perfectly formed and functioning anastomosis.

In 72 hours (Fig 8c) the slough has completely separated even along the edges of the anastomotic opening and is being replaced by healthy granulation tissue.

The 8 day gross specimen reveals the mucous membrane in the anastomotic opening completely healed over.

Microscopically the 24 hour specimen shows the slough with the picture of coagulation necrosis (Fig 9a A). The slough is definitely still adherent but separating in places. The agglutinated seroserosus surfaces (Fig 9a, B) demonstrates the rather air tight union of these two surfaces. The 48 hour microscopic section (Fig 9b) demonstrates the separation of the slough, A. Along the periphery there are still some adherent strands of slough. The area of coagulation necrosis is definitely demarcated from the healthy intestinal wall. In 72 hours the remaining slough is completely separated.

In 8 days the mucosa is completely regenerated and healed from one side of the anastomotic opening to the other (Fig 9c A).

EVALUATION

We do not agree with Ward (2) that the electrocoagulation procedure cannot be relied upon on the stomach with its redundant mucosa. The failure is purely one of lack of properly performing the electrosurgical technique especially as to the depth and strength of the current and the degree of coagulation.

The technique of J. E. Briggs and L. R.

Whitaker, calling for only one row of sutures in our experience is adequate.

The attempt of W. W. Walker to perfect an aseptic anastomosis technique that would immediately open the loops at operation to our mind has no relation to the technique as it is described by J. F. Briggs, Ward or ourselves.

In retrospect there are only extremely rare instances in which immediate anastomoses are necessary. In cases in which immediate intestinal drainage is necessary temporary ileostomy, colostomy or appendicostomy can be performed. In cases of intestinal resection the anastomosis can be performed below the lumen of the resected bowel and the lumen allowed to drain externally while the anastomosis forms and begins to function.

The question most frequently asked is 'How does one know that the anastomosis will always form?' If the procedure is carried out as described, the anastomosis will always form. In a long series we never failed even in our early experience with this method.

Secondary hemorrhage is feared by many. We have never seen a case of secondary hemorrhage in 15 consecutive operations by this method. All the animals were carefully watched after operation and at autopsy for this complication.

POSSIBLE APPLICATIONS TO THE HUMAN

1. Gastro-enterostomy—by electrocoagulation when a such procedure is necessary in repairing a perforated duodenal ulcer complicated by stricture.

2. Lateral anastomosis after resection of segments of the bowel secondary to partial gangrene of a portion of the bowel as in strangulated Richter's hernia, gangrene due to bands femoral hernia etc. The two open ends of the loop left externally for drainage until the obstruction is relieved. The fistula can be then allowed to close spontaneously or repaired secondarily. This same procedure can be applied in performing an entero-colostomy.

3. A. Ileosigmoidostomy as a preliminary procedure to resection of the caecum.

B. Ileosigmoidostomy of choice with a temporary colostomy or appendicostomy.

4. Mickulicz operation completed in the first stage of the operation eliminating the secondary clamping

5. Cholecystgastrostomy or enterostomy

6. Anastomosis of ureters to large bowel

7. Without obstruction primary resection of large intestine with side-to-side anastomosis instead of the Mickulicz operation

SUMMARY AND CONCLUSIONS

Fifteen consecutive and diversified anastomoses as performed on the dog and one as

performed on man were successfully performed by electrocoagulation technique without mortality leakage infection or hemorrhage

The procedure might in the future represent another step forward in surgical advancement.

We are deeply indebted to Dr. Leona McCloskey for her valuable assistance in the conduct of this work.

REFERENCES

1. BRIDGES, J. E. and WHITTAKER, L. R. *New England J. Med.* 1939, 301: 1
2. KELLY, HOWARD, A. and WARD, GRANT E. *Electro-Surgery*. Philadelphia: W. B. Saunders Co. 1939

THE ACTIVITY OF HAIR FOLLICLES WITH REFERENCE TO PREGNANCY

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THE condition of pregnancy is believed by many to influence hair growth in given regions of the body. However there is no unanimity of opinion either as to the question whether growth is retarded or accelerated or with reference as to which areas are affected. Diverse observations have been made both on man and on some of the lower mammals.

As early as 1875 Slocum reported the case of a woman in whom hypertrichosis developed during each of three pregnancies, and *post partum* the hypertrichosis disappeared. Halban (1906) found quite regularly an increased growth of hair on the face of pregnant women but this growth was more marked when the tendency toward hypertrichosis was already present. He also mentions an increased growth of lanugo hair over the whole body and especially in the region of the linea alba between the umbilicus and the pubic region. In each instance there was a return to normal *post partum*. In 1913 Harabath concluded that increased hair growth appears so regularly and typically in pregnant women that its appearance may be listed under the external symptoms of pregnancy. Many citations of cases of increased hair growth during pregnancy may be found in the literature but there are also some cases reported of retarded

hair growth coincidental with the period of gestation (Bechet 1921 Ochs, 1928). These observations on women have been made for the most part by physicians who saw them as patients and had their attention called to the altered hair growth by the patient. In other words, the individuals were a selected group.

The reports on animals are of quite a different character however. In that experiments were planned and carried out on unselected groups in which were included control series Halban (1907) shaved the abdomen of female rabbits in a group half of which were pregnant. The hair regenerated much more quickly on the pregnant ones than on the control group. Harabath (1913) observed hypertrichosis in three pregnant dogs especially marked over the abdomen and to a less extent over the whole body. On the other hand Dawson (1933) found a marked retardation of hair growth in pregnant guinea pigs particularly over the back, normal growth rate being restored *post partum*. Strangeways, later in the same year (1933) also observed these phenomena in guinea pigs.

Thus it appears that pregnancy retards hair growth in some species of the lower mammals and accelerates it in others. There is evidence that both effects are produced in man. The observations reported in this paper were made

in order to ascertain the effect of pregnancy on hair growth in certain selected regions of a group of unselected women

Seven women, whose co-operation was obtained through the obstetrical clinic of Washington University, permitted weekly examinations for a period of approximately 9 months. The period was divided in each case into two parts by the birth of the child—thus the examinations were made during the latter part of the pregnant period and for several months following delivery. The subjects, their ages, the number of the pregnancy in each case, and the lengths of the periods before and after delivery are shown in Table I

TABLE I

Subject	Age (years)	Pregnancy	Weeks before delivery	Weeks after delivery
B	30	First	5	14
F	26	First	17	20
G	30	Second	13	14
M	24	First	5	5
Sa	26	Third	17	17
Bc	30	First	25	13
St	24	Second	25	8

The average length of the period over which each woman was examined was 36 weeks, 21 weeks before delivery and 15 weeks after delivery

The color of the head hair was medium or dark brown in each case except that of M whose hair was red. The pubic perineal and lumbar regions were chosen for observation. The terminal hair of the pubic and perineal regions appears and acquires its distinguishing characteristics during puberty and is thus probably influenced by the changes occurring in the reproductive system at this time as much as if not more than hair on any other part of the body. (The axillary hair of course is in the same category as the hair of the pubic and perineal regions but was not chosen for the experiment because of the quite prevalent custom of frequently shaving the arm pits). The lumbar region is covered with hair of the lanugo type which is typical of the general hairy covering of the body. In each region from ten to fifteen follicles were marked by in-

jecting a small amount of India ink under the skin on either side of the follicle. These ink marks are permanent and therefore insure the identification of the follicle from week to week. Measurements of the hairs of the marked follicles were made weekly with a millimeter ruler

The behavior of the follicle is known to be cyclic in character, i.e., a period of hair growth followed by a quiescent period after which the hair falls out and the growth period of the next hair is begun (Trotter, 1924). Thus, the measurement of the hairs made at regular intervals provides information on the rate of growth, the length of the active (or growth) period and the length of the quiescent (or rest) period of the cycle through which the follicle passes and the ultimate length of the hair. Since all hairs in a given region are not in the same phase of the cycle at the same time, only part of the hairs at the time of the first measurement would be at the beginning of their growth period. The stage of the cycle of any individual hair was purely a matter of chance and not evident until after the second measurement. This resulted therefore, in not having in every case full information on the growth and quiescent periods of the same hair i.e., on the complete cycle of the follicle

The hospital routine includes shaving the pubic and perineal regions just before delivery and whereas this proved to be a slight inconvenience from the standpoint of the experiment no information was lost. The hairs in the growing phase of the cycle continued to grow and this length added to the length of the hair before shaving gave the ultimate length whereas those hairs in the resting phase of the cycle continued to remain quiescent and their cut ends which were on a level with the surface of the skin were plainly visible. The measurements on all the hairs in each region of each individual were averaged. The data are summarized in Table II

A comparison of the rate of weekly growth before and after delivery in each of the three regions shows a slightly higher growth rate in some before delivery and in others after delivery. In no individual is the difference a marked one. On the whole the tendency, although inappreciable and probably within the

range of error is for a somewhat faster rate of growth after delivery than before. There does appear however a tendency for the hair of the perineal region to grow faster than the hair of the pubic region and for the hair of the lumbar region to grow the most slowly. There was no difference in the number of growing hairs during pregnancy and after delivery.

TABLE II—AVERAGE MEASUREMENTS OF FOLLICULAR ACTIVITY IN THE PUBIC PERINEAL AND LUMBAR REGIONS OF SEVEN WOMEN

Subject	Rate of growth (mm per week) before delivery	Rate of growth (mm per week) after delivery	Growth period (weeks)	Rest period (weeks)	Ultimate length (mm)	
Pubic region	B	3	15	14	34	
	F	3	3	5	31	
	G		4	3	3	
	M	8	6	14	35	
	Sa	7	3	3	43	
	Sc	7	8	14	43	
Perineal region	S	5	6	13	33	
	B	8	7	10	7	
	F	3	8	3	19	33
	G	7	7	9	31	
	M	3	2.6	11	73	
	Sa	9		14	19	46
Lumbar region	Sc	7	6	3	19	39
	Sa	7	3	17		65
	B	9		6		19
	F	9	6	4	19	9
	G		3	9	7	
	M		7		9	
	Sa		3		19	
	Sc		4	19	3	
	St		4	6	3	

The length of the growth period and of the quiescent period of the follicle and the total length of the hair are recorded without reference to the termination of pregnancy; this was essential because of the limited time over which the experiment was carried. Nine months is a relatively long period when the patience and time of the subject is considered but a relatively short one when it is considered that a complete follicular cycle covers from 5 to 8 months. The growth period for the hair of the pubic and perineal regions is of

longer duration than the quiescent period, but in the lumbar region it is approximately only half as long as the quiescent period. The quiescent periods of follicles of the lumbar and perineal regions are about the same length, whereas the quiescent period of the follicles of the pubic region is somewhat longer.

The lengths of the hair in the three regions are also variable. The perineal region has hair which is only slightly longer than the hair of the pubic region but the hair of the lumbar region is very much shorter (approximately one fifth as long) than either of these. Thus, it appears that the shorter hair (lumbar) has a much longer quiescent period than growth period and that the longer hair (pubic and perineal) has a somewhat longer growth period than quiescent period—of these two regions the perineal hair is the longer with a definitely longer growth period than rest whereas the pubic hair which is not quite so long as the perineal has growth and quiescent periods of more nearly equal length. It may be noted also that the lengths of the individual growth periods of the pubic and perineal regions are approximately equal (exactly equal in the case of B, F and G) with the exception of M whose perineal hair grows for a much longer period than her pubic hair. The similarity in length of the growth periods of the two regions in the 6 individuals is further evidence that the excessive length of the hairs of the perineal region is due to a faster rate of growth. However the number of subjects is too small to warrant either stating an average for the group or calculating a correlation between two or more of the observations recorded.

It may be assumed that the rate of weekly growth times the length of the growth period which is given in weeks should indicate the exact total length of the hair. This does not always follow and the discrepancy is explained by the fact that the rate of growth data are compilations of partial cycles of follicular activity (the weekly rate of growth could be determined from measurements of length for only a few consecutive weeks of the growth period) also the ultimate length of the hair could be determined after the quiescent period was recognized which necessitated only a few

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weeks, whereas the length of the growth period could only be determined from follicles which had been observed from the time the hair appeared until the quiescent phase was established. Thus, many more hairs contributed information on rate of growth and on ultimate length of the hair than on the length of the growth or of the rest periods, both requiring observations throughout the entire period. The discrepancy, therefore, is the result of individual variation of the hairs.

The amount of hair in the regions under observation did not change perceptibly during the entire period of 9 months. Nor could any one of the subjects notice alteration in any part of the hairy covering of her body.

SUMMARY

Measurements on the rate of hair growth in the pubic, perineal, and lumbar regions of a group of seven women made during the latter months of pregnancy and the first several months following delivery showed no variations which could be attributed to the pregnant condition. The duration of the growth

period was longer for the longer hairs (pubic and perineal) than for the shorter hairs (lumbar). The quiescent period of the follicular cycle was longer than the growth period in the lumbar region, considerably shorter than the growth period in the perineal region, and only inappreciably shorter in the pubic region.

REFERENCES

1. BECKETT, P. E. Diseases of the skin in pregnancy. *Med. Rec.*, 1915 87 19.
2. DAWSON, H. L. On hair growth a study of the effect of pregnancy on the activity of the follicle in the guinea-pig (*Cavia cobaya*). *Am. J. Anat.* 1933 53 89.
3. HALBAN, J. Ueber ein bisher nicht beachtetes Schwangerschaftssymptom (Hypertrichosis graviditatis). *Wien klin. Wchnschr.* 1906, 19 6.
4. Idem. Zur Frage der Graviditishypertrichosis. *Wien klin. Wchnschr.* 1907 45 1389.
5. HAMBATH, R. Ueber Graviditishypertrichosis. *Gynaek. Rundschau*, 1913, 19 705.
6. OCHS, Alopecia areata. *Arch. Dermat. & Syph.* 1929, 19 693.
7. SLOCUM, C. E. A case of hirsuties gestationis. *Med. Rec.* 1875 10 470.
8. STRANGEWAYS, D. H. The effect of pregnancy on hair growth and shedding in the guinea pig. *J. Agric. Sc.* 1933 23 379.
9. TROTTER, M. The life cycles of hair in selected regions of the body. *Am. J. Phys. Anthropol.* 1924, 7 427.

CLINICAL SURGERY

FROM THE STANFORD SURGICAL SERVICE

AN OPERATION FOR TUBERCULOUS EMPYEMA

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THE ordinary form of rib resection with introduction of a drainage tube is notoriously unsatisfactory in tuberculous empyema, especially in empyemas the pus of which contains either tubercle bacilli alone or no demonstrable organism at all i.e. empyemas not secondarily infected. So called closed drainage, drainage by means of a tube introduced into an intercostal space through a trocar is equally bad. Both of these methods always lead to secondary infection and almost always to fever, sepsis, and death.

Some forms of tuberculous empyema, however, occasionally purely tuberculous ones, more often secondarily infected ones, produce such constantly high swinging temperatures and such severe symptoms of toxicity that surgeons are impelled again and again to drain in spite of previous warnings and in spite of full knowledge of the trouble that usually ensues.

Several methods of treatment are proposed for such toxic tuberculous empyemas. Aspiration with a syringe, replacement of the pus by an equal quantity of air and irrigation of the pyopneumothorax cavity with countless varieties of antiseptic solutions have been recommended. Aspiration often results in abatement of fever and sepsis for a few days and even weeks, but usually needs to be repeated so often and so long that both the doctor's and the sufferer's patience are exhausted. At times it leads to cure, usually not.

Oleothorax (injection of gonemol and various other antiseptic or aseptic oils) has led to good results in some hands (Matson) to disastrous results in others.

Extensive thoracoplasty may succeed in obliterating the empyema cavity but the operation needs be extensive and formidable. It entails considerable risk to patients weakened by long toxic illness and considerable crippling at best.

Cure of these tuberculous empyemas is made difficult by the tenacity with which the underly-

ing lung resists expansion. It is also made difficult by the unfavorable effect of an indwelling drainage tube of any kind. The presence of the tube itself, I think, tends to keep up fever and sepsis. Some tuberculous empyemas treated ill advisedly by rib resection and drainage heal if one does nothing more than remove the drainage tube.

A desire to obviate a drainage tube led to an operation which has proved of use in a number of secondarily infected tuberculous empyemas. Encouraged by its success it has with some hesitancy recently been used in a few obstinately toxic tuberculous empyemas, in which no pus forming organisms could be found.

The operation causes the underlying lung to expand. It is, therefore, *not applicable* to those empyemas in which the lung is so badly affected that expansion to any degree seems inadvisable. The question of applicability must be decided by clinical pulmonary symptoms and especially by X-rays taken prior to the appearance of the complicating empyema. If cough and expectoration of baciliferous bearing sputum still persist and if early roentgenograms reveal large cavities or other extensive parenchymal damage, some form of thoracoplasty is probably safer. Fortunately, in many empyemas the lung seems little if at all affected and partial if not total expansion seems allowable. If but partial expansion seems advisable the operation to be described should be complemented by an upper thoracoplasty.

TECHNIQUE

Under local anesthesia a U-shaped flap of skin and subcutis is outlined about half way between the posterior axillary line and the line of the inferior scapular angle. The flap has a base about 3 inches wide which lies about one rib higher than the bottom of the empyema cavity so that the rising diaphragm may not stop drainage. It is about $3\frac{1}{2}$ inches long, the length of two ribs and

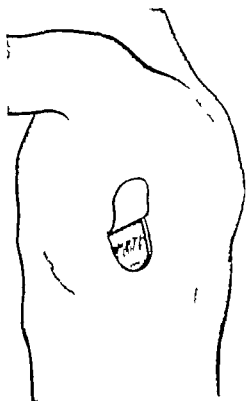


Fig. 1 Flap of skin outlined

their intercostal spaces long enough to reach into the pleural cavity with out the least tension and longer therefore in fat patients than in lean ones. The rib underling the top of the flap is resected the amount resected equalling the width of the flap. If the flap is too narrow and the resection too scant drainage will be insufficient. It is good

I think, to strip the rib with a cautery instead of a raspatory and to inject the bared intercostal nerve with 1 cubic centimeter of absolute alcohol. The tip of this flap is turned into the chest and tacked to the pleura with one or two chromic catgut stitches the edges of the defect in the skin are approximated with a few stitches of silk worm.

This thoracotomy needs no tube for the skin flap which lies against the soft parts of the chest keeps the wound open. It remains open until the lung reaches the chest wall after which it spontaneously and automatically closes without further ado. It has a valve action each cough or rise in intrapulmonary air pressure expels a little air

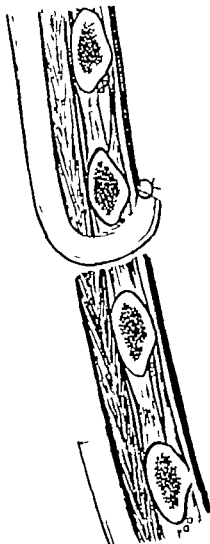


Fig. 2 Cross section of chest wall showing skin flap turned into chest and attached to pleura

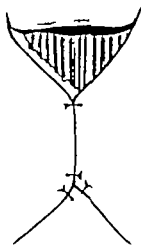


Fig. 3

Fig. 3 Skin flap turned into chest cavity edges of defect approximated by sutures

from the thorax and causes a gradually increasing negative pressure in the empyema cavity, for it is more difficult for air to enter through this valve-like wound than to escape from it. This fact is readily demonstrable (although in theory the valve might seem to work the other way) if

the wound is opened by an instrument at a change of dressings when air will enter it with a sucking sound. If much negative pressure is desired over zealous and overcleanly nurses should be cautioned not to change the dressings or to content themselves with changing the outer ones only and to leave the inner ones in place as long as possible—for many days.

This operation it will be seen differs entirely both in theory and practice from the valve recently proposed by Nichol for acute empyema. Details with X rays case histories and other data will soon be published.¹

¹ Western J. Surg.

BIRTH FRACTURES OF THE FEMUR

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THE problem of caring for fractures of the newborn the result of birth injuries occupies a rather unique position in medical science in that it concerns no particular specialty. This fact at once becomes evident when search is made in the literature reference must be made not only to the obstetric and pediatric, but also to the orthopedic and surgical literature. It is surprising moreover how little has been written on the subject at least in so far as data regarding the final results are concerned.

For the purpose of acquiring a wider knowledge of the entire problem study has been made of the fracture material found at the Obstetrical Clinic in Lund during the years 1900-1934. It is the preliminary report of this investigation that I present in this paper. The present report concerns fractures of the femur only.

During the study three main points were kept especially in mind: (1) the immediate process of healing, (2) the prognosis, especially with respect to the end result, (3) the best treatment.

Only brief mention will be made of our findings regarding these points as brought out in our study of the literature.

As to the immediate process of healing it is well known that the healing tendency in infants is great and that even a severe displacement can be remolded into an anatomically good result through the forces of nature (v. Reuss, Naujoks).

As to the final results, the accounts given in the literature are very few. As a rule however it is evident that the favorable result of primary union has been taken as a warranty that the final result will also be good. A few isolated reports of poor results, especially regarding resultant shortenings, have been made (Staffier, Krukenberg, Naujoks). In these cases, however, the time of final examination was not more than 10 years after birth.

The question of treatment has received more attention in the literature than the two other points in question, and a number of different methods have been recommended. Up to the present time, however, no definite agreement has been arrived at as to which is the best method. Generally speaking the methods proposed may be classified into two main types: fixation without extension on the body (Crédé, Kuestner, Dollinger and others) by means of plaster of Paris (Dollinger) with splints (Labatier, Spitzky) and

extension in some form (Schede, Riise, Jones, Oert, Schanz, Gordon and others). Of these two different types of treatment, the former that is, simple fixation without extension, may be said to be employed in more cases than is the extension method.

AUTHOR'S STUDY OF CASES

My own study of the records of the fractures occurring at the Obstetrical Clinic in Lund show that in approximately 40,000 deliveries there were 16 fractures of the femur. All of these fractures, except 2 occurred in breech presentations. Of the two exceptions one occurred in delivery by cesarean section the other in the manual bringing down of an extended leg. The oldest fracture dates from 1914.

With reference to the first point as to the immediate process of healing, an examination of the 13 remaining fractures (3 infants died during birth) confirms the statements made in the literature as regards rapid healing. Union of the fractured bones is so rapid that, on the basis of weeks as a suitable unit of time in the treatment of fractures in adults, we must reckon with days in infants—soft callus appears even in a few days, and bony callus has been observed even in the first week (Bors). This emphasizes the fact that definite reposition should be completed within this time otherwise the opportunity of obtaining a satisfactory position will be lost at least lateral dislocations and shortenings will then be difficult to correct. Indeed the majority of reports of our cases, as they now appear in the records and in the roentgenogram, bear witness to the difficulties encountered for it is evident that in spite of repeated attempts at reposition and fixation the fractures were usually left to unite in an anatomically bad position.

The most common malposition is, as appears from the illustrations, medial displacement and flexion of the proximal fragment, this malposition being produced by the contraction of the flexors and adductors inserted on this fragment. Shortening is also a usual finding and is generally marked in certain cases it may be at least one fourth of the length of the femur (Fig. 6).

Oseous union occurred, however in all cases and sufficient firmness was acquired within 14 days. In those cases in which the process of healing was followed by means of radiographic exam-



Fig. 1 left Fresh fracture of the femur. The three following illustrations show the rapid healing and spontaneous correction.

Fig. 2 The same fracture after 3 weeks. Large callus. No better position could be obtained. Extension was not tried.

inations for somewhat longer periods after fracture it was evident how wonderfully even severe malpositions were modified and gradually assumed a position quite satisfactory anatomically. It should be noted that this process of remodeling has taken place for the most part during the first 6 months of life and not, as might be expected after the child had commenced to stand on its legs (Figs. 1-4). Hence there is no need of weights to guide the spontaneous correction of the malposed member; the normal tonus and play of the musculature seem to be sufficient for this purpose.

Thus, in spite of the fact that in general the fractures were allowed to unite in an anatomically unsatisfactory position, osseous union always did occur; second, the malposition was spontaneously reduced in a rather short time. As we shall bring out later, no inconvenience has been experienced and no suffering has been noted in the early period of growth. The result as to primary healing can therefore quite justly be characterized as good.

In order to obtain an idea as to the final result in these cases, follow-up examinations of the 6 oldest fractures of the femur were made. A brief summary of these 6 cases follows:

CASE 1. No. 495/1924. Male child had a fracture of the left femur following breech presentation. Labor was long and extraction was accomplished by fillet. The fracture was fixed in various ways for a period of 3 weeks. The result was healing in bad position. Healing was normal and patient learned to walk when 16 months old. He has never had any subjective trouble. In 1933, Dr. Brandberg reported that the boy was then 9 years of age and the roent-

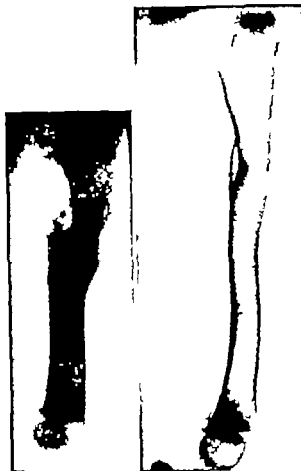


Fig. 3 left The same fracture after 7 weeks. Spontaneous correction has commenced.

Fig. 4 The same fracture after 10 months. The position is good.

genogram showed a marked, even, forward curvature of the upper part of the femur. The left leg was 0.5 centimeter shorter than the right. A certain forward curvature was also visible in the upper part of the thigh (Figs. 5-7).

CASE 2. No. 907/1919. A female infant received a fracture of the left femur during prolonged labor, breech presentation, and extraction by fillet. Fixation along the trunk was maintained for 14 days. Primary position of fragments was bad. The process of healing was normal. Patient learned to walk in the usual time and had no subjective trouble until the last 2 years when she began to notice that the left leg was weaker than the right but the weakness was so slight that it was hardly noticeable. In 1934, when she was 15 years old, an X-ray examination showed only a slight trace of the fracture. Both legs were of equal length. The left thigh was 1.5 centimeters smaller around than the right thigh; the left calf was 0.5 centimeter smaller. A near result of the application of the fillet, was noticeable in the medial part of the groin (Figs. 8-10).

CASE 3. No. 418/1919. A male infant in breech presentation received a fracture of the left femur during delivery. The mother was febrile and extraction was accomplished by fillet. Fixation of the fracture was maintained for 18 days. No roentgenogram was taken. Normal union took place and patient learned to walk at the usual time. He has never had any subjective symptoms. In 1934, when he was 15 years old, examination showed no more than a trace of the fracture. The legs were of equal length. In circumference the left leg measured 0.5 centimeter less than the



Fig 5



Fig 6



Fig 7

Fig 5 Fresh fracture in bad position, Case 1

Fig 6 The same fracture as in Figure 5 after 5 weeks. Large callus. Very bad position. No extension, Case 1

Fig 7 The same fracture as shown in Figures 5 and 6 after 9 years. There is still marked curvature of the femur, Case 1

right. A plainly visible scar was noted in the groin the result of the application of the fillet. The ability to extend the leg was somewhat limited in both hip joints. Marked lumbar lordosis with pelvis projecting backward was noted (Figs 1-12).

CASE 4 No. 504/014. A male infant received a fracture of the left femur during delivery. The child was in breech presentation and threatening asphyxia prompted extraction by fillet. Fixation on trunk was maintained for 3 weeks. Primary position was bad. Healing proceeded normally. Patient learned to walk in the usual time and had no trouble during childhood. He began to notice symp-

oms at the age of 5 or 10 years but even though pain increased slightly it was only moderate at all times. He walked with a raised heel. In 1934, at 20 years of age, the roentgenogram showed but a very slight trace of the old fracture. The left leg was almost 2 centimeters shorter than the right, at the thigh it was 2 centimeters more around. The pelvis was oblique (Figs 13-15).

CASE 5 No. 058/014. A female child, in breech presentation suffered a fracture of the left femur during delivery. Labor was atonic. Extraction was accomplished by fillet. Fixation to trunk was maintained for 8 days. Primary position was bad. Union took place normally and patient



Fig 8



Fig 9

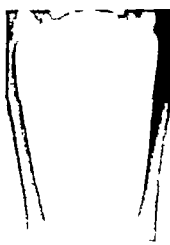


Fig 10

Fig 8 Fracture of the femur. Marked callus already present. Bad position. No extension, Case 2

Fig 9 The same fracture as in Figure 8 after 15 years

Now only a slight thickening of the femur remains, Case 2

Fig 10 The same case as in Figures 8 and 9. The fillet has left a scar in the medial part of the left groin, Case 2

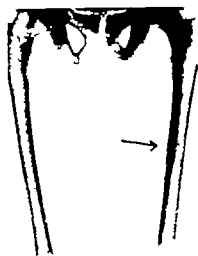


Fig. 11. Fracture of the femur in patient 15 years old. Hardly any traces are evident. Case 3.

learned to walk 2 months later than her twin sister. A new fracture of the same femur was sustained when she was 5 years of age. Apart from the latter fracture, no subjective symptoms were noted either before or after. In 1934, when patient was 20 years old, a roentgenogram showed only a trace of the fracture. The left leg was 2 centimeters shorter. Girth of both thighs was the same. The pelvis was oblique (Figs. 16-17).

CASE 6 No. 34/1914. A male infant had a fracture of the right femur sustained during birth. The child was in transverse position; delivery was accomplished by version and extraction by bringing down the extended leg. Frac-

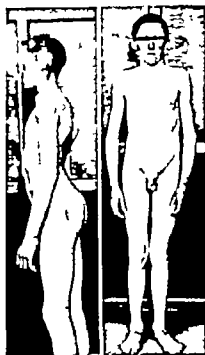


Fig. 12. The same case as in Figure 11 at the age of 15 years. Scar after the fillet in the left groin. Reduced extension in the hip joints. Lumbar lordosis. Case 3.

ture was held in position by fixation to trunk. Primary position was rather bad. Healing proceeded normally. He learned to walk in the usual time and never had any subjective trouble; in fact he enlisted in the standing army. In 1934, Dr. Thunström reported that patient, then 20 years



Fig. 13.



Fig. 14.

Fig. 13. Fresh fracture of the femur. Bad position. No extension. Case 4.

Fig. 14. Patient now 15 months old. Curvature and shortening of the femur still remain. Case 4.



Fig. 15.

Fig. 15. Roentgenogram taken when patient was 20 years of age. A complete correction of the deformity has taken place. A shortening of 2 centimeters remains. Case 4.



Fig. 16.

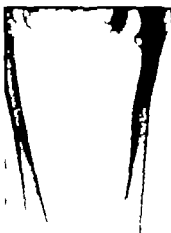


Fig. 17

Fig. 16. Fresh fracture. Rather bad position. No extension. Case 5.

Fig. 17. The same case as in Figure 16 at the age of 30. Another fracture of the same femur occurred at the age of 5 years. Now a shortening of 2 centimeters. Case 5.

Fig. 17a. The same case as in Figure 17. There is shortening of the left leg with increased pelvis. Case 5.



Fig. 17a

of age, showed hardly any trace of the fracture by roentgenogram, the right leg was 2 centimeters shorter than the left, the girth of both thighs was equal, the pelvis oblique compensatory scoliosis was noticeable (Figs. 8-10).

SURVEY OF CASES

What has just been said with reference to the result of the primary healing is therefore clinically confirmed by these cases. No trouble has been experienced by the patients from birth fractures during the age of growth, all of them learned to walk in the usual time, with the possible exception of Case 1. Thus, even from a clinical point of view the result of the primary healing has been good.

As to the final result, the roentgenographic anatomical examination shows that even in this respect the result has been good. Of the 6 patients who were followed up, and whose ages varied from 9 to 20 years, 5 showed scarcely any trace at all of the old fracture in the roentgenogram. In 1 case there still remained a curvature at the site of the old fracture. Hence the end-results in this respect are very satisfactory. This is true, however, only from a pure roentgenographic anatomical point of view. In other respects some change or other remains discernible.

Two of the patients (Cases 2 and 4) have experienced subjective trouble, very slight, it is true, but noticeable. One of them has a shortening of 2 centimeters. Another patient (Case 6) has a shortening of 3 centimeters. One patient (Case 3) has only a scar in the groin to remind

him of the fracture, a deep lumbar lordosis and somewhat restricted power of extension in the hip joints of this patient cannot with certainty be ascribed to the fracture. In one of the patients (Case 1) the curvature of the femur mentioned is discernible to the naked eye as a forward bending of the thigh. Another of the patients (Case 5) had a new fracture of the same femur when she was 5 years old (for which reason no definite judgment can be formed with regard to the final result, still it is quite possible that the second fracture occurred in a *locus minoris resistentie* at the site of the original birth fracture (no roentgenogram was taken on the second occasion).

Now the question arises as to whether on the whole any significance is to be attached to these changes as shown in a study of the final results. It may be thought that owing to the fact that they are so minute they should be regarded as of no importance. It is interesting to note that in those cases in which trouble has been experienced



Fig. 18



Fig. 19



Fig. 19a



Fig. 19b

Fig. 18. Fresh, 6 day fracture of the femur. No extension. Case 6.

Fig. 19. Patient now 20 years old. Fracture is scarcely visible. There is, however, a shortening of 2 centimeters. Case 6.

Fig. 19a. Compensatory scoliosis with convexity to the side of the shortened right leg. Case 6.

Fig. 19b. The same case as in Figures 18 and 19. Shortening of the right leg. The pelvis is inclined with spina iliaca anterior superior and the gluteal fold lower on the right side than on the left. Patient has a scoliosis with the convexity to the right. There is a deep impression present in the right groin which has been left by the fillet. Case 6.

the trouble did not manifest itself until several years after birth. This may signify that such difficulty will increase as the patient grows older and too the possibility cannot be excluded that the patients who are at present free from symptoms will later on in life develop symptoms of

static insufficiency. Thus we should not allow ourselves to be deceived by the beautiful roentgenograms obtained in the following examinations but rather bear in mind that in a clinical sense the result may not always be entirely in accord with the X ray picture.

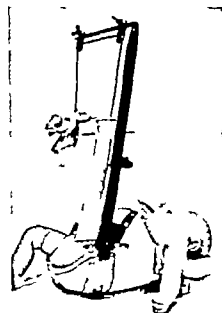


Fig. 20

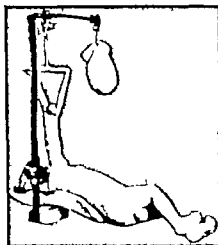


Fig. 21



Fig. 22

Fig. 20. The extension apparatus applied for a fracture of the femur.

Fig. 21. The extension apparatus applied for a fracture of the humerus.

Fig. 22. Nursing is not disturbed.



Fig. 23



Fig. 24

Fig. 23. left. Fresh fracture of the femur

Fig. 24. The same patient as in Figure 23 after 26 days. Treated in the extension apparatus. The only case without shortening

TREATMENT

From what has been said it is evident that the treatment must aim at a definite result so that even the ultimate result will be entirely satisfactory. This point merits special emphasis since the difficulties encountered in treating fractures in these little patients where the primary union is almost always good may otherwise encourage carelessness.

The treatment employed up to last year at this clinic was fixation of the fractured leg close to the body with the foot at one of the shoulders sometimes with, and sometimes without wooden splints. In exceptional cases plaster of Paris or metal splints bent at right angles have been used (Spitar). The period of fixation has in general been 2 to 3 weeks. The patients have then been discharged and no further treatment has been given. Extension treatment was not employed previously but was introduced last year. The advantages of this latter method of treatment have, however, been so great that it should undoubtedly be preferred to simple fixation. Shortening perhaps the most important malposition, cannot possibly be avoided but by extension (Fig. 24).

The type of extension employed at this clinic was first advanced by Schanz (1928) and later on also described by Obadalek (1933). The principle of this method is to make extension possible without having to fix the child to an uncomfortable cot, which is rather difficult to move about. With this method the child can be easily carried about with the entire extension apparatus applied. Similar methods have been previously mentioned by Boorstein, Gordon, and others.



Fig. 25. The same case as in Figures 23 and 24 after 11 months

Of the older methods the simple fixation treatment, with or without splints, also possessed the same advantage that it allowed the child to be carried round but it had one drawback in that it frequently gave an unsatisfactory reduction of the fracture and required almost daily dressing. The extension treatment in which the extension apparatus was attached to a bed (Schede) had the advantage of giving a better reducing result but it was inconvenient for one thing because it rendered nursing difficult.

The new method of extension introduced by Schanz combines the advantages of the two older methods mentioned without possessing any of their disadvantages. The technical arrangements are simple as may be seen from the pictures (Figs. 20-21). On a bed of plaster of Paris an extension gallows made of iron is fixed on a level with the hip joints. This device may be jointed at the base. A new plaster-of-paris bed can be made for each separate case, the extension gallows being adjusted to the hip of the child, or to one of its shoulder joints in the case of a fractured humerus. If desirable the surgeon may have four such beds in readiness, one for each extremity. The apparatus can easily be made by any blacksmith or ordered from some firm of instrument makers. The application of the extension device to the fractured limb can be performed by means of zinc glue or mastoid but the simplest way is to use a good quality of common adhesive plaster.

The weight extension is generally made so heavy that the lower part of the patient's body is lifted a little from the plaster-of-paris bed. The patient is then suitably held to the bed by means

of a wide bandage. The period of fixation varies from 2 to 3 weeks.

Although the entire arrangement may perhaps appear rather complicated, it is in fact very easy to superintend during the course of treatment. If the apparatus is ready for use the work of attaching the child to it can be accomplished in a very short time. That it fixes the fracture in a firmer manner than by fixing the limb on the body is evidenced by the fact that the child's crying is considerably less when the leg is extended. An other advantage is that, once the extension bed has been applied to the fracture there is no need of repeated bandaging or so much supervision as in the majority of other methods of fixation. A fracture once reduced can be easily kept in position by this method. Finally, it does not in any way hinder nursing (Fig 22). Its main advantage, however, is that it insures a better reduction than any other treatment without extension.

SUMMARY

An investigation has been made of the records of birth fractures at the Obstetrical Clinic at Lund during the years 1900-1934. During this period 16 fractures of the femur occurred. Three children died in connection with delivery. The 13 remaining were examined.

1 Reposition was always difficult. The fractures were frequently left to unite in an anatomically unsatisfactory position. Osseous union has always occurred, however, in a short time. The mal union has been reduced by a spontaneous remoulding into a satisfactory position in the course of the following months. No trouble has been experienced by the patients during the period of growth. The children all learned to walk in the usual time. The *primary healing result* has therefore been good.

2 The examination of the *final results* in the 6 oldest patients at present from 9 to 20 years of age, has shown that in 1 case there still remains a marked curvature of the femur at the site of the old fracture whereas in the 5 other cases hardly any trace of the fracture can at present be seen in the roentgenogram. In several cases however various changes were observable, such as, subjective trouble and shortening. These changes were indeed very slight but they cannot be denied every importance.

3 The best *method of treatment* has been found to be extension, the method employed being ex-

tension in a portable plaster-of paris bed (Schanz 1928). Reduction should be completed after the first few days or at any rate within a week of the occurrence of the fracture. Otherwise it will be rendered more difficult on account of the early formation of callus.

BIBLIOGRAPHY

- 1 BOORSTEIN, S. W. Treatment of birth fractures at Fordham hospital. *Am. J. Dis. Child.* 1920, 19: 375-383.
- 2 BORS, E. Betrachtungen zur Frakturheilung im Säuglingsalter. *Zentralbl. f. Chir.* 1928, p. 2185.
- 3 DOLLMEIER, Die Behandlung Oberschenkel- und Oberarmfrakturen. *Deutsche Zeitschr. f. Chir.* 1902, 65: 570.
- 4 EWOKI, E. Kindliche Knochenbrüche unter der Geburt. Inaugural Dissertation. Berlin, 1905.
- 5 FLEMMING, G. B. Recognition and treatment of birth injuries in the newly born. *Brit. M. J.* 1931.
- 6 GORDON, D. Treatment of birth fractures. *Am. J. Surg.* 1920, 6: 768-770.
- 7 ISERHART, Fracture of the thigh in the newborn. *Brit. M. J.* 1909, p. 951.
- 8 JONES, R. On the treatment of fracture of the femur in the newly-born. *Brit. M. J.* 1905, 1: 1358.
- 9 KRIKORIAN, Med. Klin. 1930, vol. 3. (Cit. Naujoks).
- 10 KUNSTNER, O. Ueber die Verletzungen der Extremitäten des Kindes bei der Geburt. A. F. Volkmann's Vorträge, 1880, No. 167.
- 11 NAUJOKS, H. Die Geburtsverletzungen des Kindes. Stuttgart F. Enke, 1934.
- 12 Idem. Zur Prognose kindlicher Geburtsverletzungen. *Arch. Gynaek.* 1928, 135: 414.
- 13 OBADLER, W. Die Extensionsbehandlung der Säuglingsfrakturen im Gipsbett. *Der Chirurg* 1933, 5: 382.
- 14 OKKI, Beitrag zur chirurgischen Behandlung der Neugeborenen. *Beitr. z. Geb. u. Gynaek.* 1909, 13: 309.
- 15 REUSE, A. Pathologie des Neugeborenen. Biologie und Pathologie des Weibes, 8: Halban-Seitz. Vienna. Urban & Schwarzenberg, 1927.
- 16 v. REUSE, A. R. Die Krankheiten des Neugeborenen. Enzyklopaedie der klinischen Medizin. Berlin, 1914.
- 17 RIECK, E. Behandlung der Schenkelbrüche Neugeborener durch permanente Extension. *Deutsche med. Wchnschr.* 1904, p. 1539.
- 18 SCHAEK, Praktische Orthopaedie. Berlin J. Springer 1928.
- 19 SPITZ (Lange). *Chir. u. Orthop. im Kindesalter*. Pfäunders-Schlossmann Handb. d. Kindh. vol. 5. Berlin. Vogel, 1910.
- 20 STAFFIER, H. Ueber die Prognose intra partum erworbener Frakturen. Inaugural Dissertation. Halle a. S., 1915.
- 21 TRUEDDLE, E. D. Inequality of the lower extremities following fracture of the shaft of the femur in children. *Ann. Surg.* 1921, 74: 498.
- 22 Idem. Birth Fractures and Epiphyseal Dislocations. New York: Paul B. Hoeber 1917.

PERIPHERAL NERVE BLOCK IN OBLITERATIVE VASCULAR DISEASE OF THE LOWER EXTREMITY

FURTHER EXPERIENCE WITH ALCOHOL INJECTION OR CRUSHING OF SENSORY NERVES OF LOWER LEG

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FOUR years ago we reported a technique for alcohol injection of the sensory nerves of the lower extremity (4) in order to relieve the intense rest pain in cases of advanced obliterative vascular disease. At that time our series consisted of 11 cases and the immediate results were gratifying both to us and to the patients. Since then we have employed this procedure in over 50 patients. Sufficient time has elapsed to report our results in the first 45 cases, and to state our present feeling in regard to the value of this operation not only in relieving pain but also as an effective method of treating the disease.

CASES SUITABLE FOR OPERATION

The cases may be divided into two groups according to the pathological process in the vessels (Table I). Twenty-eight were classified under the diagnosis of thrombo-angiitis obliterans, and 17 as arteriosclerosis. We wish to emphasize that the patients in this series are suffering from an advanced stage of the disease with extensive obliteration of main vessels, with severe rest pain, and in nearly every case with ulceration or extensive gangrene. They are not the early cases which usually respond to systematic hygiene, postural exercises, rest, forced fluids, and elimination or curtailment of the use of tobacco, as has been previously described (1). These are cases which for the most part have had a trial of conservative treatment in the hospital for 1 to 2 weeks before resorting to this operation.

ANATOMY AND TECHNIQUE

The anatomy of the lower leg and the technique of operation were described in detail in our first article (4). This will be repeated briefly to emphasize certain points which we believe to be important. Figure 1 shows the position of the five nerves supplying sensation to the foot. It may be necessary to block one or all of these nerves in a given case. They are exposed through small vertical incisions in the middle or upper thirds of the lower leg, under local anesthesia. Only one nerve should be blocked at a time. The others can be done at intervals of a few days to

a week. We believe that too extensive an operation at one sitting may result in rapid advancement of gangrene in the foot, as occurred in one of our first cases. The operation should be done with the greatest care and asepsis. It is essential to know exactly where the nerve in question lies. This knowledge can be acquired only by careful dissection of amputated limbs, and nobody should attempt this operation until he is thoroughly familiar with the course of the nerves. There should be no lateral dissection of the layers. One should be able to place the skin incision exactly over the nerve avoiding intramuscular fascial septa where small collateral arteries are prone to run. Tooth forceps, rake retractors, and such coarse instruments should never be used. In these advanced cases it is almost never necessary to use a hemostat. There are no sporting vessels. If the incisions are properly placed, and the capillary oozing in the fat layer can readily be controlled by gentle pressure with a gauze sponge. When it is necessary to incise the deep fascial layer we do not advise suturing it. Only the finest of plain catgut ties (No. 000) are used when necessary. Silk sutures are placed in the skin without the aid of forceps. Perfect approximation is essential, and sutures should be tied loosely. Operation should never be done in the presence of lymphangitis. Incisions should never be made near areas of migrating phlebitis.

METHOD OF BLOCKING THE NERVE

In the earlier cases (3) the nerve was carefully freed and the surrounding tissues protected by moist gauze. A segment of the nerve, defined between two snug catgut ties, was then distended with 95 per cent alcohol (Fig. 2). The object of this technique was to localize the extent of nerve injected so that the time of regeneration could be controlled and to prevent irregular diffusion of alcohol along the nerve. This we felt was sometimes followed by paresthesias due to incomplete necrosis of nerve fibers at the upper limit of alcohol diffusion. In the more recent cases we have simply crushed the nerve with an instrument over an extent of $\frac{1}{4}$ inch if rapid regeneration was

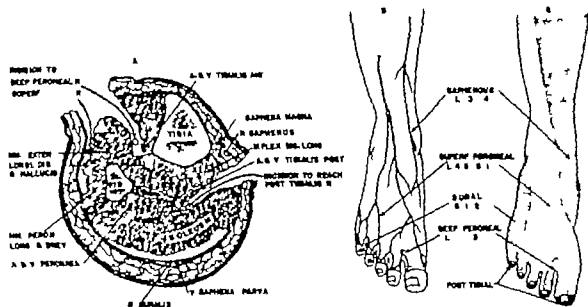


Fig. 1 Showing the anatomical position of the five nerves supplying sensation to the foot and the areas supplied by each. They can be blocked through small vertical incisions in the middle and upper thirds of the lower leg without causing important motor paralysis. Adapted from John Homans' *Textbook of Surgery* 1935

desired or up to $\frac{1}{2}$ inch if prolonged anesthesia seemed necessary. We favor this latter technique at present because it can be done through a shorter incision, takes less time and avoids the danger of spilling alcohol into the tissues. Crushed nerves regenerate more rapidly and apparently as completely as those injected with alcohol. A nerve crushed over an extent of $\frac{1}{4}$ inch will regenerate in about 3 months. We do not favor actual section and suture of the nerve as has been advocated by Laskey and Silbert, because this would appear to make the operation unnecessarily complicated and difficult, although it would, of course, be equally effective.

COMPLICATIONS

Most of the complications which follow this operation are the result of faulty technique. Among those which we have encountered are delayed healing of the incision, infection in the wound, ulceration of the anesthetic skin as a result of improper weight bearing and unnecessary pressure from poorly fitting shoes, precipitation of gangrene of the foot following too extensive an operation at one sitting.

All of these we have practically eliminated by improvement in technique and careful attention to weight bearing and proper shoes after operation. If the deep peroneal nerve is blocked in the upper third of the leg, paralysis of the extensor hallucis longus may result. In this case an ulcer may develop on the plantar surface of the great toe due to improper weight bearing because of

toe drop. Amputation of this toe may be necessary. The intrinsic muscles of the foot are temporarily paralyzed following block of the posterior tibial nerve. This will be followed by atrophy of the muscles concerned, which as far as we know has never resulted in any important loss of function.

BENEFICIAL SEQUELAE

Besides the elimination of pain, which alone is sufficient indication for the operation, other important changes take place. First of all, the general condition of the patient improves. He is able to sleep, eat, and carry out other conservative measures such as postural exercises. He is able to curtail or eliminate his tobacco. Locally, infection can better be controlled by frequent antiseptic dressings, slough can be trimmed away, and the healing of the wound is greatly accelerated.

The circulation to the part may actually be materially increased because the anesthetic area is completely sympathectomized. Certain of these patients have a large element of vascular spasm as well as obliteration. As the efferent vasoconstrictor sympathetic fibers lie intermingled with the sensory components of the peripheral nerves, they likewise are blocked. The anesthetic area is therefore sympathectomized and the surface temperature may be elevated as much as 15 degrees F in some cases (Fig. 3). This, of course, is temporary and as sensation returns, vascular spasm returns. If the surface temperature rise has been marked, this operation

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE I.—THROMBO-ANGIITIS OBLITERANS

Case No. Hosp. N.	Age	Local lesions	Peripheral vessels Pop. D. P. T.	Nerves blocked	Minor amputation	Major amputation	End result
201495	30	Great toe amputated for gangrene. Severe and severe pain in stump		Posterior tibial	Great toe		Slow but painless healing of de-arterialized toe in months
201496	30	Ulceration of tip of right great toe		Cutaneous branch of peroneal, posterior tibial, right	Right great toe		Terminal phalanx removed, pain relieved, but infection extended along flexor tendon sheath as far as calcus. Toe amputated
		Partial unhealed amputation stump right great toe		Posterior tibial, superficial and deep peroneal, right		Guth-Stokes, right	Pain not relieved because gangrene extended beyond anesthetic area, Guth-Stokes amputation
		Severe pain and discoloration in toes of left foot		Superficial and deep peroneal, posterior tibial, left		Guth-Stokes, left	Pain only partially relieved because gangrene extended into lower leg, Guth-Stokes amputation
201497	30	Continued pain in foot after amputation of second and third right toes for gangrene	+	Cutaneous branch of superficial peroneal, deep peroneal, and posterior tibial	Second and third toes, right		Complete relief of pain. Healed in months
		Partial gangrene left great toe	+	Superficial and deep peroneal, posterior tibial	Left great toe		Toe amputated. Stump failed to heal, pain relieved but suppurated
		Discharging sinus in amputation stump, left great toe	+	Superficial and deep peroneal, posterior tibial, saphenous, and sacral	Second, third, and fourth toes left		Pain not relieved and healing incomplete
		Left foot stump unhealed and infected	+	Superficial peroneal, sacral, and saphenous	Heels of all metatarsals		Complete relief of pain. Healed slowly with skin graft, 3 months after operation
201498	43	Partial ulcer of great toe	+	Posterior tibial, deep peroneal, and cutaneous peroneal		Guth-Stokes	Final amputation, as ulcers did not heal
201499	37	Partial ulcers dorsum of foot and great toe		Posterior tibial, cutaneous peroneal, and sacral			Pain relieved, ulcers healed
201500	45	Partial ulcer of great toe	+	Sacral, posterior tibial, and superficial peroneal		Guth-Stokes	Ulcer failed to heal. Guth-Stokes amputation
201501	45	Partial ulcer right second toe		Superficial and deep peroneal, posterior tibial			Pain relieved. Tip of toe healing on discharge
		Trophic ulcer great toe from too deep and faulty weight bearing			Right great toe		Right great toe amputated
		Partial gangrene right third toe		Superficial and deep peroneal			Pain relieved. Toe healed
		Partial gangrene right second toe		Superficial and deep peroneal, posterior tibial	Right second toe		Pain partially relieved. Toe healed
		Partial ulcer right third toe			Right third, fourth, and fifth toes		Right third toe amputated, fourth and fifth toes normal, compensated for prephyria
		Partial gangrene left great toe, ulcer fourth toe	+	Posterior tibial, superficial and deep peroneal	All toes, heels of metatarsals, second, third and fourth		Great toe amputated, gangrene extended, second, third, and fourth toes amputated, finally fifth toe amputated because useless
		Partial gangrene right third toe	+	Posterior tibial and superficial peroneal	Right second and third toes		Pain immediately relieved. Infection spread, second and third toes amputated
201502	49	Partial beginning gangrene right great toe	+	Superficial and deep peroneal, posterior tibial	Right great toe		Pain relieved but toe still sloughing. Toe amputated, healed well. All symptoms returned after time.

SMITHWICK WHITE PERIPHERAL NERVE BLOCK IN VASCULAR DISEASE 1109

TABLE I.—THROMBO-ANGITIS OBLITERANS—Continued

Case No. Hosp. No.	Age	Local lesion	Peripheral vessels Pop. D P T.	Nerve blocked	Minor amputation	Major amputation	End-result
10 256606	43	<p><i>Early I</i> Painful ulcer with beginning gangrene in stump of right great toe and between fourth and fifth toes</p> <p><i>II</i> Amputation stump of left fifth toe was healed and painful</p>	o	Posterior tibial, superficial and deep peroneal	Right second and fifth toes		Pain relieved. Gangrenous areas became sharply defined; second and fifth toes amputated. Foot amputation advised but patient refused. Discharged with open areas. All nerves regenerated 1 year later. 3 years later still one clean ulcer open
11 205749	33	Painful beginning gangrene great toe and lateral aspect right foot	o o	Superficial peroneal and posterior tibial	Left fourth toe		Left foot amputation advised but patient refused. Gangrene developed at fourth left toe which was then amputated
12 2057	33	Pain in all toes of right foot, great and fifth toes infected	+	Sciatic	Left fifth toe		Ulcer healing and painless on discharge
3 207565	37	Pain in right great toe recurrent (with osteomyelitis)	+	Posterior tibial and superficial peroneal	Right great toe		Toes healing, pain relieved for 3 months
4 203113	44	Left great toe amputated for gangrene, pain in stump	o	Deep peroneal, saphenous, sciatic	Right great toe		Right great toe amputated and sole of foot drained. Healing on discharge
5 211648	33	Painful gangrene right third toe	+	Posterior tibial, superficial and deep peroneal		Left foot at ankle + Grith-Stokes	Gangrene progressed in foot, amputated at ankle 15 days after injection. Grith-Stokes 3 days later
6 207383	36	Infection in left great toe, moderate pain in foot	+	Posterior tibial, superficial and deep peroneal		Right leg below knee	Pain completely relieved but recurred after 1 month. Amputated. Gangrene progressed to ball of foot and pain recurred. Amputation below knee done 6 weeks after injection
7 207547	39	Painful same right fifth toe	+	Posterior tibial			Toes improved but still unhealed on discharge. Nerves all regenerated 6 months later
8 20706	34	Right second, third, and fourth toes amputated, ulcers healed and sloughing, severe pain in foot, especially great toe	+	Sciatic, posterior tibial, saphenous	Right fourth and fifth toes		Pain relieved. Fourth and fifth toes healed slowly and completely
9 21479	39	Amputation stumps of right great and fifth toes painful on dressing	o o o	Posterior tibial, superficial and deep peroneal		Grith-Stokes, right	Gangrene developed in great toe, incision for nerve block did not heal, pain continued. Grith-Stokes amputation done 3 weeks after injection
10 210146	34	Painful ulcer right great toe, dry skin second toe	+	Sciatic, superficial peroneal, posterior tibial	Right first and fifth metatarsals		Stumps of both toes broke down 3 months after section, but only slightly painful. Head of first metatarsal removed, fifth metatarsal stump carried. Four months later amputation of non-healing great toe stump. Took 3 months more to heal. Nerves regenerated 8 months after block
11 2102	35	Painful gangrene in stump of first metatarsal right	+	Superficial and deep peroneal, posterior tibial	Right great and second toes		Pain relieved but toes did not heal. Second toe amputated 9 days after alcohol injection. Great toe developed gangrene 3 months later amputated
12 2102	35	Painful ulcer left great toe, whole foot discolored	+	Superficial and deep peroneal, posterior tibial, sciatic		1 Foot at ankle + Grith-Stokes	Entire dorsum of foot became ulcerated and gangrenous, amputation at ankle then Grith-Stokes

*The average duration of symptoms was 3 years, 6 months in the thrombo-angitis obliterans group, and 1 year 6 months in the arteriosclerosis group. The interval between serious involvement of the two legs in the cases in which bilateral nerve block was necessary was 3 years.

TABLE I —THROMBO-ANGIITIS OBLITERANS—Continued

Case No.	Age	Local lesion	Peripheral vessels Pop D P T	Nerves blocked	Minor amputation	Major amputation	End-result
34 30660	46	Painful ulcer right fifth toe		Sural			Patient returned to hospital 3 weeks after nerve block with ulcer healed though pain improved. Nerve block became useless. After 3 months toe ulcer healed, incision still open. Grafts applied, postoperative sym- ptomatically with success and signi- ficance of sensory loss alone without effect on healing of nerve block in- cision. Lumbar sympathectomy gang- lionectomy done, followed by healing.
35 318377	48	Painful threatened gas- trocnemius claudication of left leg, ulcer at base of great toe	+	Posterior tibial, superficial peroneal, sural	Great and fifth toes left	Orchi- ectomy, left	Gangrene progressed, great and fifth toes amputated, gangrene appeared on fourth toe. Orchi-ectomy ampu- tation of leg done. Pain completely relieved.
36 346132	39	Painful gangrene right great toe, beginning gas- trocnemius second toe	+	Posterior tibial, superficial and deep peroneal	Right great toe		Dry gangrene at tip of great toe re- solved. Amputation, gangrene and ulcers healed 5 months after nerve block.
37 346132	39	Ulcers of great and second toes, left		Superficial peroneal, posterior tibial	Left second toe		Ulcers did not heal. Gangrene devel- oped on second toe. Toe amputated, followed by painful healing.
38 346132	46	Right great toe nail bed infected, whole foot discolored and painful		Superficial and deep peroneal	Right great toe	Right lower leg	Gangrene developed in great toe. Toe amputated. Ulcers failed to heal. Re-amputation foot mechanical in- fection spread. Gangrene ampu- tation of lower leg done, followed by re-amputation 3 inches below knee.
39 346132	46	Left great toe nail bed sloughing	+		Left great toe		Circulation not improved by medical measures. Toe amputated. Amputa- tion wound ulcerated. Lumbar ganglionectomy done, stump healed, wound healed 4 months after ampu- tation.
40 346132	46	Right third and fourth toes ulcer- ated	+				Right lumbar ganglionectomy done. Healing not effected.
41 346132	46	Right third and fourth toes ulcer- ated	+	Posterior tibial, superficial and deep peroneal	Right third and fourth toes		Right fourth toe amputated. Nerve block done for pain in stump. Toe third toe amputated. Slow healing, complete in 6 months.
42 346132	46	Ulceration between left fourth and fifth toes		All 5 nerves	Left fourth and fifth toes and metatarsals		Pain relieved but healing not effected. Toes amputated. Slow healing com- pleted by amputation. Nerve blocks required on return of pain.
43 346132	46	Ulceration left third toe	+		Left third toe		All remaining toes of both feet to be amputated.
44 346132	3	Painful ulcers tips of fourth and fifth toes		Sural, posterior tibial, superficial peroneal		Orchi- ectomy, left	Pain relieved temporarily but 6 weeks later gangrene commenced in fifth toe with severe pain. Superficial peroneal nerve blocked again. Gas- trocnemius extended into foot, poor heal- ing of nerve block incision. Orchi- ectomy amputation done.
45 346132	34	Pain and swelling left leg, ulcers on leg at sites of previous nerve injections		Superficial and deep peroneal, sural, saphenous		Low thigh, gastrocnemius, left	Gangrene developed, low thigh ampu- tation done. Amputation stump pained 1 year later. Posterior lumbar cutaneous nerve blocked. Pain not completely relieved. Stump re-amputated, postoperative healed. Later cordectomy for pain.

*The average duration of symptoms was 3 years, 6 months in the thrombo-angiitis obliterans group, and 1 year, 8 months in the arteriosclerosis group. The interval between serious involvement of the two legs in the same in which bilateral nerve block was necessary was 1 year.

SMITHWICK, WHITE PERIPHERAL NERVE BLOCK IN VASCULAR DISEASE 1111

TABLE I—Continued—ARTERIOSCLEROSIS

Case No. Hosp No	Age	Local lesion	Peripheral vessels Pop D P T	Nerves blocked	Minor amputation	Major amputation	End-result
30 184184	43	Beginning gangrene of first 3 toes, left	o	Cutaneous branch of peroneal, and posterior tibial		Gritti-Stokes, left	Gangrene and pain spread rapidly to lower leg Gritti-Stokes amputation
30 196130	70	Threatened gangrene of right foot, severe pain in first 3 toes	o o o	Cutaneous branch of peroneal, deep peroneal, and posterior tibial		Gritti-Stokes, right	Paralese gangrene of foot in 10 days Gritti-Stokes amputation
3 243508	70	Non-healing ulcer lateral lower third of leg	+ o	Peroneal anastomotic and external saphenous branches of sural nerve	Left fifth toe		Ulcer healed slowly and painlessly. Lesion also healed slowly with minor sepsis
3 208163	67	Ulcer of fifth toe with septic point Continued pain after amputation of toe	+ o	Posterior tibial, cutaneous peroneal, and musculo-cutaneous		Lower thigh, left	Relief of pain Gangrene advanced slowly forcing amputation of leg
33- 297497	67	Painful gangrene of left great toe	o o	Posterior tibial		Gritti-Stokes, right	Rapid spread of gangrene Amputation of leg done
34 208100	63	Painful gangrene of right fifth toe	o o o	Posterior tibial, cutaneous peroneal		Right lower thigh	Ulcer continued dirty and sloughing Leg amputated at mid-thigh 3 days after infection
35 10395	55	Large painful ulcer over right tibia, pain extending into foot and up to groin	o o o	Saphenous			Ulcer healed but pain not relieved
36 209043	50	Painful ulcer side of right foot	o o	Sural			Pain completely relieved for 3 mos
37 209043	50	Ulcer side of right foot healed but still painful	o	Sural			Ulcer practically healed, no pain, no regeneration after 3 months
37 209043	50	Painful ulcer re-entrant		Superficial peroneal			Ulcer unimproved, but toe amputated through part of proximal phalanx 3 months later clean ulcer over Fourth toe gangrenous, this amputated. Nerve still completely blocked
37 209043	50	Painful ulcer of left fifth toe		Sural, superficial peroneal posterior tibial	Left fifth and fourth toes		Amputation wound of fifth toe did not heal Leg amputation done 3 months later
38 215584	60	Painful gangrenous stump of right fifth toe	o	Sural, posterior tibial, superficial peroneal	Right fifth metatarsal	Right leg	Slow healing Pain relieved
39 31473	70	Painful ulcer with beginning gangrene in left fifth toe	+	Sural, posterior tibial, superficial peroneal			Wound healing, pain gone except for itching on dorsum of foot on discharge
40 3102	70	Gangrene of left great toe with severe pain	o o o	Posterior tibial, superficial and deep peroneal		Gritti-Stokes, left	Ulcer failed to heal, lymphangitis developed, Gritti-Stokes amputation
41 319083	61	Painful ulcer on dorsum of left foot	+	Superficial peroneal			Stumps healed on discharge Amputation of leg advised, refused by patient Pain entirely relieved
41 319083	41	Amputation stumps fourth and fifth toes unable to tolerate dressings	o	Posterior tibial, sural, superficial peroneal		Left lower leg	Patient returned to hospital 4 weeks after last nerve block with ulcer unhealed and painful, lymphangitis, and threatened gangrene. Amputation at lower third of tibia
42 314630	7	Painful ulcer sole of left foot with discoloration of whole foot	o o o	Posterior tibial, sural, superficial and deep peroneal		Low thigh right	Gangrene spread left foot Low thigh amputation done
44 3138	8	Continued pain in stump of right second toe after amputation for gangrene	o	Superficial and deep peroneal, posterior tibial		Gritti-Stokes, right	Gangrene spread and became more painful Gritti-Stokes amputation done 4 months after block
45 209100	69	Painful beginning gangrene of right foot, especially third and fourth toes	+	Superficial peroneal			

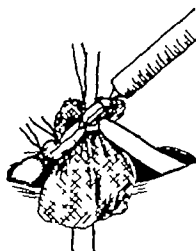


Fig. 2. Method of injecting alcohol into a nerve. Alcohol is injected into a small segment of nerve defined by two long ties. These are later removed. We feel this prevents irregular diffusion of the solution along the nerve which may result in paresthesia rather than anesthesia. The duration of anesthesia depends upon the length of the segment of nerve which is injected.

should be followed by lumbar ganglionectomy in selected cases. Lastly the anesthetic area is dry. This diminishes heat loss from the skin surface by radiation and convection, which are much greater in the presence of moisture.

RESULTS

It is of course difficult to compare the results of this series with those obtained in a similar series not treated by this method. Table II gives a comparison between the first 25 consecutive cases of thrombo-angitis obliterans treated by this method and the preceding 25 similar cases treated by other methods. It shows a marked increase in the number of successful minor amputations and a marked decrease in the number of major amputations necessary in the cases treated by

TABLE II.—THROMBO-ANGITIS OBLITERANS

	25 cases without nerve block	25 cases with nerve block
Amputation unnecessary	1	4
Minor amputations	7	14
Unilateral major amputations	11	0
Bilateral major amputations	6	1
Percentage of involved extremities having major amputations	74%	30%

Showing a decrease in the number of cases in which no amputation is necessary, an increase in the number of successful minor amputations, a decrease in unilateral major amputations, and a striking decrease in the number of bilateral major amputations in the nerve block cases.

nerve block. We would particularly call attention to the decrease in the number of necessary bilateral major amputations in the nerve block series. Table III shows the distributions of major and minor amputations in this series of 45 cases. Again we would emphasize the fact that only one bilateral major amputation was necessary in this series. Five cases required amputation of one or more toes in both feet, but were saved from bilateral major amputations. In our opinion these good results were due solely to this operation. Figures 4 and 5 show end-results in 2 cases.

The results are better in the patients with thrombo-angitis obliterans than in the arteriosclerotic group as shown in Table IV, where the influence of the different pathological processes is brought out. As has been previously emphasized, the average age is much less and the duration of symptoms much longer in the patients suffering with thrombo-angitis obliterans (1). This, of course, gives a much better opportunity for the development of collateral circulation. The presence or absence of popliteal pulsation is important in both groups from the point of view of end-results, but less so in the case of thrombo-angitis obliterans. Here one is much more likely to avoid a major amputation in the absence of popliteal pulsation than in the arteriosclerotic group (Table V).

To speak for a minute about minor amputations. We are impressed by the fact that the difficulty usually involves one or two toes, rarely more. After these have been successfully healed with the aid of minor amputations, there are left two or three useless toes which in our experience are very apt to get the patient into future serious difficulty because of minor trauma and poor hygiene. In several cases we have had to block the same nerves several times on different entries for successive gangrene of one toe after another. The nerves had regenerated between admissions. We are favorably impressed by the results of prophylactic amputation of these remaining superfluous toes by the method of lateral slips through the middle of the proximal phalanx, as

TABLE III.—AMPUTATIONS

	Disease	
	Thrombo-angitis obliterans	Arteriosclerosis
Bilateral major	1	0
Unilateral major	0	10
Bilateral minor	5	0
Unilateral minor	8	3
Amp. unnecessary	4	4
Total	28	17
		45

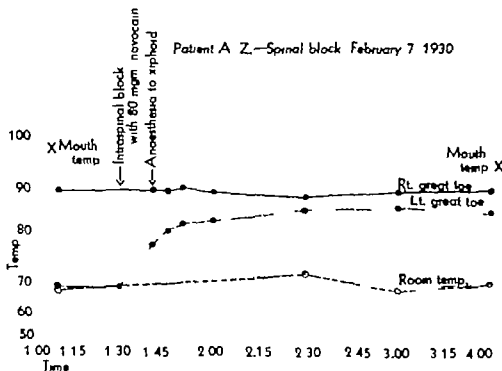


Fig. 3. Surface temperature rise after nerve block. Case 24 (Table I). Chart showing a surface temperature rise of nearly 20 degrees F. in the right great toe following nerve block. After spinal anesthesia, which paralyzes the lumbar sympathetic trunks, there is no further rise of surface temperature in this toe, suggesting that it has been very completely sympathetomized by peripheral nerve block. The surface temperature of the left great toe, however, does rise approximately 18 degrees F. for the duration of the spinal anesthesia. (Reproduced by permission, *New England Journal of Medicine* 3.)

shown in Figure 5. This almost ensures the patient against future episodes of ulceration and gangrene which usually start in the tip of a toe and rarely in the foot itself. The resulting foot with the heads of the metatarsals preserved is functionally satisfactory provided the toe of the shoe is stuffed with sponge rubber or lamb's wool to prevent sliding forward into the shoe. At times a $\frac{1}{4}$ inch metatarsal bar is a great help.

Practically all of the major amputations in this series were of the low thigh or Gritti Stokes type. We are not favorably impressed by the end results in lower leg (point of election) amputations for advanced obliterative vascular disease. Recurrent ulceration and pain are so frequent that they become of great economic importance

TABLE IV

Disease	Extremities involved	Major amputations number	per cent
Thrombo-angitis obliterans	34	12	35.3
Arteriosclerosis	17	10	58.8

Showing the influence of the pathological process upon the loss of extremities. Major amputations are relatively more frequent in the arteriosclerotic group.

and in many cases prevent the patient from using his permanent leg much more than 50 per cent of the time. The only cases in which we occasionally do point of election amputations are young individuals who are thin and in whom the probability of loss of the other extremity is great. We have several patients (only one in this series) who have had bilateral Gritti Stokes amputations and get about very well on a pair of short legs. From the preceding remarks it is obvious that major amputations are still necessary at times although we

TABLE V

Disease	Number of extremities	Major amputations Number	Per cent
Popliteal pulsation present—			
Thrombo-angitis obliterans	16	4	25.0
Arteriosclerosis	7	3	42.9
Popliteal pulsation absent—			
Thrombo-angitis obliterans	17	8	47.1
Arteriosclerosis	11	8	72.7

Showing the influence of extent of obliteration upon the end-result. Major amputations are more frequent in the absence of popliteal pulsation, particularly in the arteriosclerotic group.



Fig. 4 End result, Case 3 (Table I). Loss of second and third toes of right foot and all toes and heads of all metatarsal bones of left foot.



Fig. 5 End result, Case 36 (Table I). After multiple amputations, minor amputations, and repeated nerve block, the first, third, and fifth toes of the right foot and the third toe of the left foot were amputated before they became involved.

feel that this operation has enabled us to more than double the number of successful minor amputations and to more than halve the number of major amputations. We believe it has also increased the number of cases in which no amputation is necessary. We still intend to do major amputations only in the presence of hopeless gangrene or sepsis which endangers the life of the patient.

CONCLUSIONS

1. Peripheral nerve block is an effective method of controlling rest pain in patients with advanced obliterative vascular disease.

2. Besides controlling pain, the circulation to the part may be increased because the anesthetic area is also deprived of its vasoconstrictor nerves.

3. Local infection in open lesions is more easily controlled because frequent antiseptic dressings can be done painlessly.

4. The general condition of the patient improves with the relief of pain and other conservative measures become more effective.

5. The operation requires careful technique, asepsis, and should be done in multiple stages. Under these circumstances complications are few.

6. The nerves may either be injected with alcohol or crushed. The latter method is more simple and equally effective, although the nerves regenerate more rapidly.

7. We believe that this procedure has more than halved the number of necessary major amputations, and more than doubled the number of successful minor amputations. It also has

increased the number of cases in which no amputation is necessary. We would particularly emphasize the striking reduction in bilateral major amputations in this series.

8. The results are better in the patients with thrombo-angitis obliterans than in the arteriosclerotic group. Patients with pulsation of the popliteal vessels do better than those in which the vessel is obliterated at this level.

9. Amputation of uninvolved toes is an effective prophylactic procedure in selected cases. If the vasomotor index is high, lumbar ganglionectomy should be done after the peripheral nerves have regenerated in certain cases.

10. Unless hopeless gangrene or infection sufficient to endanger the life of the patient is present, this operation should be tried before resorting to a major amputation. It is not indicated in the early treatment of obliterative vascular disease, but should be used in advanced stages after other conservative methods have proved inadequate.

BIBLIOGRAPHY

1. ALLEN, A. W. The general management of circulatory disorders of the extremities. *New England J. Med.* 193, 304-350.
2. LARKEY, N. F., and SILBERT, S. Thrombo-angitis obliterans, etc. *Ann. Surg.* 1933, 98: 55.
3. SMITHWICK, R. H. The treatment of peripheral vascular lesions. A. The use of foreign proteins. B. Alcohol injection of peripheral sensory nerves. *New England J. Med.* 93, 304-345.
4. SMITHWICK, R. H., and WHITE, J. C. Elimination of pain in obliterative vascular disease of the lower extremity, etc. *Surg. Gynec. & Obst.* 1930, 5: 594.

URETERO-INTESTINAL IMPLANTATION WITH DRAINAGE BY EXTRAPERITONEAL CATHETER

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IN 1925 Smitten reviewed 755 cases of uretero-intestinal implantation reported in the literature with an average surgical mortality of 33.6 per cent. Twenty nine per cent of the patients died of peritonitis and 23.4 per cent of severe pyelonephritis. Shock and pneumonia were common complications. The course of patients surviving the operation was not given. Doubtless many of them died of ascending infection or from slow renal obstruction.

This is a good representation of the experience of others. To put the ureters in the bowel always involves the two risks of infection and obstruction. The facts that birds and some reptiles normally have ureters ending in a cloaca full of pathogenic organisms and that many surgeons have been successful in imitating this anatomical relationship to the extent that patients live many years with neither of the two complications account for the belief of many surgeons that a method which will minimize these great risks will be found. Surgical efforts thus inspired go in waves and there is one of limited enthusiasm sweeping the country at present.

Almost every conceivable idea to prevent infection and ureteral obstruction has been tried. One of the important causes of failure with many methods has been the obstruction to a free outflow of urine caused by the congestion and edema at the site of implantation. Temporary obstruction from this cause may be the starting point for an acute obstructive pyelonephritis with multiple abscesses. If only one ureter has been transplanted this renal infection may subside and the kidney recover when urine begins to drain freely following the disappearance of the local edema. If bilateral transplantation has been done, the condition is much more serious. Statistics clearly show that in case of exstrophy it is safer to transplant one ureter at a time. In old people with cancer of the bladder however, every extra stage of surgery multiplies the risk by that much and a technique is needed which does not increase the risk if both ureters are transplanted at the same operation. Higgins's modification of Coffey's technique III¹ and Poth's modification of Higgins's technique² are good for two reasons, and have been performed successfully. In the first place the bowel is not opened and the technique is aseptic. In the second place, urine drains natu-

rally into the bladder and the intestinal wound about the ureter heals without contamination either of urine or faeces and without producing urinary obstruction caused by the edema of surgical trauma. However drawing the ureter over to the rectum for anastomosis without dividing it may be difficult sometimes and if the ureter is on tension when the operation is done, the ureter may be found detached at the second operation and the whole purpose be defeated.

First stage. The ureters are exposed but not divided. A portion of each is imbedded in a suitable channel of the muscular layer incised to the submucosa. The hidden intestino-ureteral suture (Koser's to Hansen) is placed. Urine drains naturally until the hidden suture cuts through.

Second stage. Each ureter is divided just below the portion which has been imbedded.

First stage. The ureters are unbedded as above but the hidden suture is not used. The lumen of the ureter is not connected with the lumen of the bowel at this time. **Second stage.** An opening of the ureter into the bowel is made with a cautery passed up the ureter after its division below the portion imbedded and this cautery is drawn out by an assistant through a proctoscope in the rectum.



Fig. 1. The right ureter is dilated and straight and the pyelogram shows a cavity formation, indicating tuberculous involvement. The urine from the right kidney shows tubercle bacilli. There is questionable involvement of the upper pole on the left. The urine from the left kidney is negative.

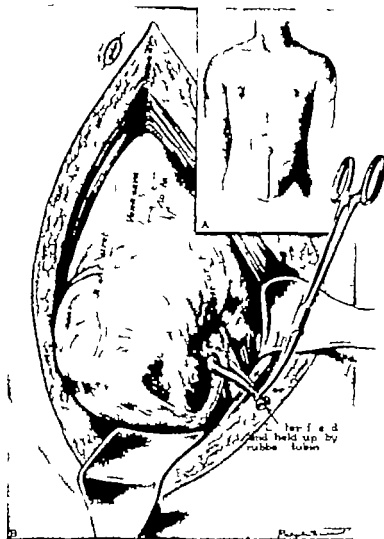


Fig. 1. A, The incision. B, Extrapertoneal exposure of the ureter which is ligated and divided near the bladder after the peritoneum has been opened and the abdomen inspected, as shown in Figure 3, and not at this stage.

A well known method of diversion of urine during the period of healing is nephrostomy. Preliminary drainage by nephrostomy reduces the risk of implantation but adds another operation. Of 7 patients on whom this was done 6 survived. The 1 who died (2 days after bilateral implantation, by Coffey's catheter technique of shock and acute dilatation of the stomach) had an extensive carcinoma of the bladder and urethra. Unilateral implantation was done in each of the 6 patients who recovered. Each had one kidney and a contracted tuberculous bladder; nephrectomy for tuberculosis having been done sometime pre-

viously in all. Two are still living comfortably; 1 lived for 3 months and the others for over a year. Four of the 6 patients died of non-surgical causes long after operation and, except in 1 patient, the cause of death was unrelated to the implantation. One died in 3 months of military tuberculosis (autopsy); 1 in 13 months of right-sided lobar pneumonia (autopsy); 1 in 3 years of unknown cause (no autopsy) probably renal insufficiency and 1 in 4½ years of calculous anuria (stone in the implanted ureter) (autopsy). Nephrostomy was indicated in these cases of tuberculosis as a therapeutic measure in itself.

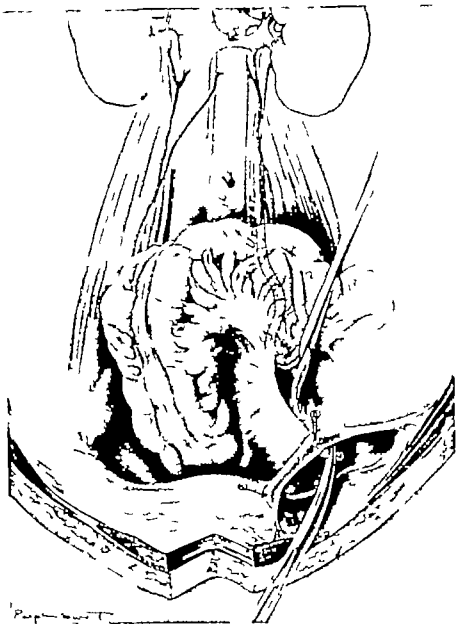


Fig 3. The peritoneum has been incised alongside that portion of the pelvic colon favorable for ureteral anastomosis and the ureter after division near the bladder is drawn out through this incision.

regardless of its relationship to ureteral implantation. Finding that the remaining kidney is free of tuberculosis, demonstration of a fairly normal ureter and of restoration of function when it had been reduced before nephrostomy give the indications for implantation of the ureter. Patients with contracted, hopelessly involved bladders get along quite comfortably with simple nephrostomy. Three such patients are now living 5, 2 and 1 years respectively with symptomless bladders and nephrostomy drainage, one because he prefers the nephrostomy tube to another operation and the other two because the lower ureters are so badly diseased that the operation

never has been proposed. However nephrostomy should not be the routine procedure in this type of case. The soundness of the remaining kidney and ureter can be determined by tests of total function and excretory urography even when the ureter cannot be catheterized and the ureter can be implanted at once without preliminary nephrostomy. Recently 2 patients, each with a nephrectomy for tuberculosis, and a tuberculous bladder but with good renal function and a normal appearing ureter have weathered direct implantation of this solitary ureter by a simple seven suture method without drainage (to be reported). The other tuberculous patients in poor

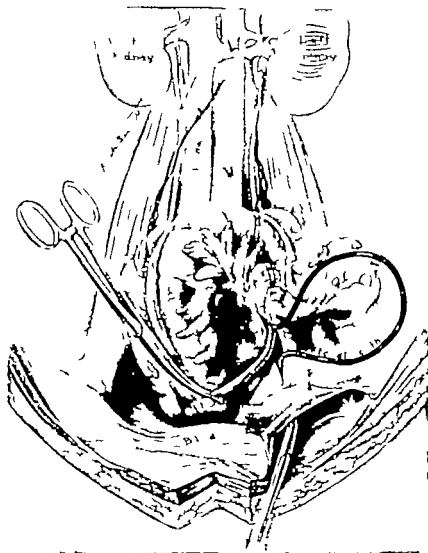


Fig. 4 The ureter is incised as high as possible under the peritoneal flap and a retention catheter is inserted. The end of this is brought out retroperitoneally.

condition succumbed from nephrostomy alone. Drainage by preliminary nephrostomy should not be regarded as a stage of uretero-intestinal implantation. It only complicates the problem by adding more surgery. It has, however, its own indications. In some patients wearing a nephrostomy tube uretero-intestinal implantation may become indicated and the fact that good drainage already is established lowers the risk of operation.

Coffey's enthusiasm over the results of catheter drainage (technique II) as a preventive of obstruction, thus permitting bilateral implantation at one operation, has led to its trial by a great many surgeons. In memory of the debt owed this

surgeon for his faithful prolonged study of the problem, it should be said that he himself regarded this method as imperfect and at the time of his death was working for a better one. The catheter which is tied to the ureter and therefore cannot be withdrawn until the ureter sloughs off is in itself a cause of complications, some of which may be fatal. Trouble originating directly from the catheter occurred in 6 of my 15 patients operated upon by this technique and 2 died in consequence of such complication. Table I.

Extraperitoneal drainage after ureterotomy for stone at any portion of the ureter is a common experience of urologists. When Coffey first dis-



Fig. 5 The ureter has been implanted by technique III of Coffey and the site of implantation is covered by the flap of peritoneum, leaving the retention catheter to drain extraperitoneally

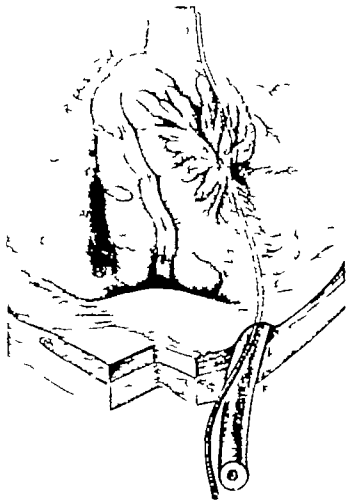


Fig. 6 Illustrates how the area of implantation can be drained retroperitoneally

cussed the aseptic advantages of the hidden suture (technique III) it occurred to me that extraperitoneal drainage as after ureterolithotomy might be used to advantage in conjunction with this technique. The trial of this method has been made in 3 patients with a good result in 2 but a fatal complication from the catheter in the third. The cases are reported in order to place on record this modification of method and at the same time to condemn it. A retention catheter in the ureter draining extraperitoneally carries the same element of danger as Coffey's Technique II with catheters draining transrectally. The accompanying illustrations explain the method as well as would description in detail

CASE REPORTS

CASE I. Mrs. C. aged 41 years, complained of frequency and nocturia for 7 months (June, 1932). A cystoscopic examination on December 28, 1932, showed the bladder to be small and contracted with a capacity of 100 cubic centimeters. There was edema about the ureteral orifices. The wall of the bladder was reddened. The right kidney was loaded with pus which

was positive for tuberculosis. The left kidney showed 5 to 10 white blood cells per high dry field. The acid fast test was negative. The phthalein test showed some diminution of function on the right side. The total function was 43.5 per cent in one half hour. Bilateral pyelograms revealed caseocavernous tuberculosis of the right kidney and were suggestive of some involvement at the upper pole of the left kidney (Fig. 1).

A right nephrectomy was done on February 1, 1933, and the pathological report showed tuberculosis of the kidney.

The patient's postoperative course was uneventful except for a small hematoma in the posterior angle of the wound which was drained adequately. At the time of discharge, there was no elevation of temperature. There was a small sinus of the posterior angle of the wound, draining very little. The phthalein test showed first hour 2 per cent, second hour 30 per cent, total, 32 per cent.

The patient was readmitted on October 10, 1933, complaining of marked urgency and frequency so that she had to sleep on a bedpan. There was constant severe pain in the lower abdomen. The symptoms had been worse since nephrectomy. The urine was cloudy. There had been no loss of weight and no respiratory symptoms.

The blood count showed red blood cells, 5.1 million; hemoglobin, 95 per cent; blood pressure 155/80. The urine was cloudy without albumin or sugar but was loaded with white blood cells. Phenolsulphonphthalein test on October 20, 1933, showed first hour 20 per cent, second hour 15 per cent, total, 35 per cent.



Fig. 7 Excretory urogram (5 minutes) of the first patient a year after uretero-intestinal implantation.

On October 9, 1933, transplantation of the left ureter into the rectum was done under spinal anesthesia with gas and oxygen. The patient's blood pressure was 60/38 at the beginning of the operation after the spinal anesthesia and 104/54 at the end of the operation. She left the table in fair condition. Her systolic blood pressure was 70, one half hour after operation. The patient responded to glucose administered intravenously.

Operative procedure. An abdominal incision was made slightly to the left of the midline. The ureter was exposed (Fig. 2) by dissecting up the peritoneum above the brim of the pelvis. The peritoneum then was opened in line with the abdominal incision. The intestines were packed off. The peritoneum was slit as near the pelvic colon as possible and the ureter drawn through this opening (Fig. 3). A small longitudinal slit was made in the ureter high in the area of the peritoneal flap (Fig. 4). A No. 6 catheter was put through into the ureter. The distal end of this catheter was brought out through the abdominal wound behind the peritoneum (Fig. 5). Urine was seen to trickle out from the catheter. The ureter was implanted at the selected area in the bowel, Coffey's technique III being used. Drains were placed retroperitoneally (Fig. 6) and the wound was closed with retention sutures of wire.

The catheter drained well. On October 23, a catheterized specimen of urine showed 75 white blood cells per high dry field, 7 red blood cells per high dry field, and a few rods. The urine was alkaline. The ureteral catheter was removed on November 1; the urine was all draining through the wound. The stool was soft and formed. The patient began passing urine by rectum 18 days after the implantation, and, within 6 days, the urine was passed entirely by rectum.

The patient was discharged on November 23, 1933, afebrile, and with all the urine being passed by rectum; the bowel movements were regular. The wound was well



Fig. 8 Excretory urogram of the second patient 2 weeks after operation. The left kidney and ureter show normal function and appearance; the right, poor function and dilatation. The rectum and pelvic colon are outlined.

healed except for some infection at the lower end. The pain in the bladder was relieved. She has been seen several times and remains well and comfortable (1 year). Figure 7 shows the last excretory urogram.

CASE 2. Mrs. L. B., aged 3 years, entered the hospital on October 5, 1933. There had been three previous entries, two in May and a third in June, 1933. At the time of the first admission, a diagnosis of epidermoid carcinoma of the vagina had been made and the subsequent entries were for the purpose of X-ray and radium therapy. This consisted of approximately 3000 milligram hours of radium and 10 X-ray treatments. Her progress had been followed closely in the Women's Clinic.

Since July 1933 she had had a foul vaginal discharge. Part of the severe lower abdominal pain had been relieved by X-ray therapy but had recurred with increased intensity several weeks before the present admission. The pain was continuous, was made worse by exertion, and seemed most severe at night. It involved the right lower quadrant of the abdomen, the back and the right hip. The patient was still able to be up and to do part of her housework. Moderate bleeding from the vagina over a period of 3 to 4 hours occurred on October 13. She developed urinary frequency and nocturia four or five times.

The physical examination was essentially negative except for the local condition. The abdomen showed normal contour. The panniculus was fairly fixed. There was an old, well healed suprapubic scar. No masses were palpable. There was considerable tenderness over the entire right

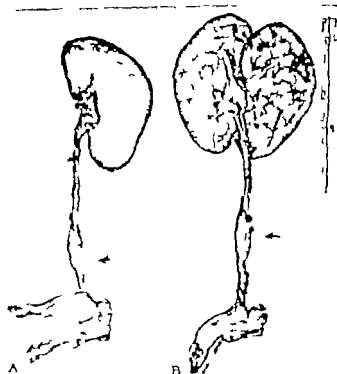


Fig. 9 The left ureter and kidney of the second patient. A, Shows the ureteral opening in the bowel. B, The kidney is neither infected nor its pelvis dilated. The entrance into the intestine appears to be direct and not oblique.

side of the abdomen. The liver edge was palpable at the costal margin. There was tenderness to pressure over the right sacro-iliac joint. On pelvic examination the vaginal vault was found to be contracted. The cervix was small. The area of the right vaginal wall was puckered and relatively well healed. Because of this fixation, nothing else could be felt beyond it. On rectal examination to the right, the parametrial region was found to be filled with a fan-shaped mass which extended outward and backward to the wall of the pelvis. Pressure on this region caused pain. The rectal lumen was not appreciably encroached upon. The blood pressure was 110/70.

The laboratory findings were as follows: blood count red blood cells, 4,100,000; white blood cells, 4,800; differential polymorphonuclears, 68 per cent; small lymphocytes, 30 per cent; large lymphocytes, 5 per cent; eosinophils, 4 per cent; mononuclears, 6 per cent. blood Wassermann test, negative; urine, negative. X-ray examination of the pelvis on October 25 showed no evidence of metastases to the bone.

On January 3 a laparotomy was done by Dr. Lynch for the purpose of exploration, the release of adhesions, and a right salpingectomy. Palpation of the parametrial region revealed that on the right side a mass extended outward from the vaginal vault toward the sides of the pelvis. This did not seem quite to reach the pelvic wall. It was firm and very slightly movable. The left parametrial connective tissue was soft with no evidence of growth. No glands could be palpated in the pelvis. Because of the patient's youth, it was felt that it would be wise to attempt to remove the entire uterus, upper vagina, and bladder. This of course could not be done without preliminary transplantation of the ureters. The writer was called in to complete this part of the operation and a bilateral ureteral transplant to the sigmoid was done. The Coffey technique III being used, supplemented by bilateral ureteros-

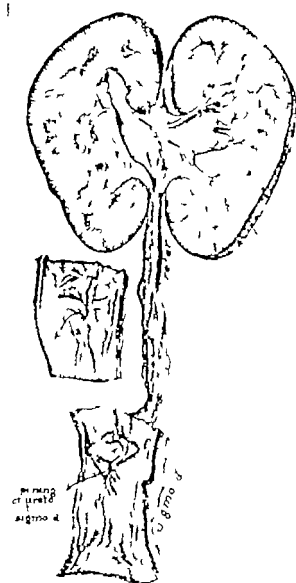


Fig. 10 Drawing of the successful implantation on the left side in Case 3 of 8 months duration.

tomy with extraperitoneal drainage by catheter as in Case 1.

The patient's postoperative course was rather stormy. She developed a fecal fistula through the wound and then an infection of the wound. Her temperature continued to rise to 38 and 39 degrees C. for many days.

On January 12, excretory urograms showed a normally functioning left kidney but hydronephrosis and hydro-ureter with a poor function for the right kidney (Fig. 8).

On January 13 a right nephrectomy was done. Considerable pus was found in the retroperitoneal area immediately surrounding the kidney and down the course of the ureter. The kidney appeared to be large. When opened the pelvis was filled with pus. Microscopically multiple cortical abscesses of the kidney with chronic pyelitis and ureteritis were found.

After irrigation and debridement of the wound, the patient's condition rapidly improved and the temperature returned to normal. The kidney incision was almost healed at the time of discharge however thick, grumous foul smelling material continued to ooze from the midline



Fig. Photographs showing the kidney, ureter, and a portion of the pelvic colon removed at autopsy in the third patient. A, The badly infected kidney and the marked arteritis above the point at which the retention catheter was inserted. B, A closer view of the ureter.

suprapubic incision. The fistulous tract was extremely small. Pelvic examination on February 6 showed the vaginal mass to have increased markedly in size and to occupy practically the entire right lateral vaginal wall. Rectally it extended backward and to the lateral wall of the pelvis. Pressure upon it produced marked pain. The growth was obviously beyond any possibility of further surgery. Pain from the right pelvic region required repeated doses of opiates for relief.

At the time of discharge on February 16 the patient's appetite had returned, she had begun to gain weight and she was strong enough to sit in a chair for a short time each day.

After leaving the hospital she was comfortable except for pain in the right lower quadrant requiring relief from 1 to 5 grains of codeine two or three times daily. She reentered the hospital on July 31, 1934, because of four severe hemorrhages from the vagina. These recurred in spite of vaginal packs, and the patient died on August 10.

Autopsy showed numerous fine adhesions between the omentum and the abdominal scar. The omentum was adherent in the pelvis. Omental fat was thin and yellow. There was no free fluid. There were numerous adhesions in the right kidney fossa and about the cecum. There was a small stump of appendix, 1 centimeter long, covered by adhesions, through which the cecum was pulled medially toward the base of the mesentery of the ileum.

Kidneys. The right kidney was absent. The left kidney was freely movable and surrounded by a thin layer of perirenal fat. It weighed 180 grams and was somewhat pale but possessed normal markings. The cortex was 0.7 centimeter thick and the pyramids were normal. The pelvis was about normal in size but the wall was fibrotic and thickened to 0.2 centimeter. The ureter was anastomosed to the sigmoid in the pelvis, an end-to-side anastomosis, which was patent through a collapsible opening which easily admitted a 3 millimeter probe. The

ureter entered the sigmoid at about a right angle and the union was very firm (Fig. 9A and B). There was no excess ureter extending into the bowel. The ureter was somewhat dilated, just above the anastomosis, measuring 0.6 centimeter in diameter for about one-third of the distance, above which it was 0.4 centimeter in diameter. The wall was slightly thickened, uniformly. At the pelvic brim the ureter was adherent to the tumor mass but was not visibly constricted nor invaded (Fig. 10).

There was a hard nodular mass involving the posterior two-thirds of the sigmoid. This was most extensive on the ventral wall. It was thick, fixed, had a necrotic ulcerated surface and discharged a foul serosanguineous exudate. The cervix was entirely eroded or replaced by the tumor. The neck of the uterus was likewise eroded and replaced, tumor tissue extending well into the body of the uterus, the lumen of which was obliterated by the growth. The tumor mass had invaded the bladder wall extensively on the vaginal and uterine surfaces.

CASE 3. Mrs. Y., aged 68 years, had her first attack of hematuria 5 years before entry. The attacks recurred with increasing frequency, becoming severe 3 to 4 months ago. A large tumor of the bladder was found at cystoscopic examination 2 months ago. This was fulgurated three separate times without much regression. On January 6, 1934, the right ureter was transplanted to the sigmoid, with a ureterostomy drain, above the implant, which came out through the midline incision extraperitoneally. The bladder was removed. The patient was in poor condition in the surgery and the left ureter, which had been partially obstructed by the tumor in the bladder, was brought to the skin at the end of the operation. The patient excreted not more than about 700 cubic centimeters of urine each 24 hours. She developed tympanites and paralytic ileus with fecal vomiting. A nasal tube was used for 3 or 4 days, with constant suction, fecal material being aspirated. The patient failed rapidly during the last 5 days, developing tracheitis and terminal bronchopneumonia. On postm-

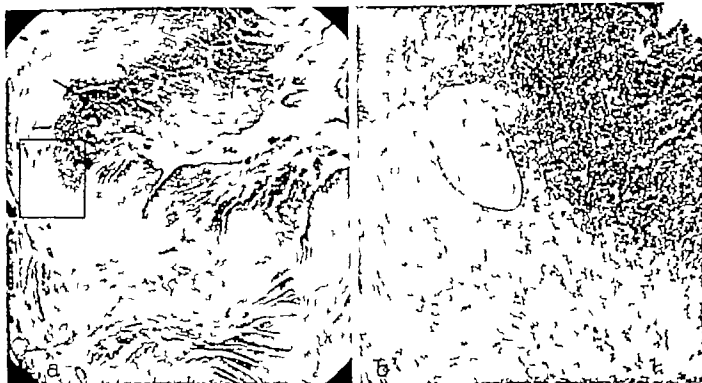


Fig 12 a, Photomicrograph of a serial section showing the right ureter entering the sigmoid in Case 3. b Higher powered photomicrograph showing the inflammatory reaction. The ureter shows atrophy and necrosis at the point of entrance through the sigmoid. a subacute inflammatory reaction is seen extending in all the coats of the bowel.

n trogen was 62.5. 2 days before death. Death occurred on January 19, 1934.

The autopsy (by Dr. Biskind) was limited to a slight lengthening of the midline abdominal incision, which showed very little healing and much unduration as the result of an inflammatory reaction. The bowel showed a few loops plastered to the incision, forming a small pocket holding an inflammatory exudate. The pelvis was greatly distorted because of the absence of the bladder and, in this region, there were several hundred cubic centimeters of a thick purulent material which had collected in a pocket.

The gastro-intestinal tract was examined from the esophagus to the rectum, and aside from the local reaction around the sigmoidostomy there was little evidence of abnormality.

The left kidney weighed 160 grams and was surrounded by a firm, perirenal fat which showed evidences of slight inflammation. The left ureter was greatly dilated and bluish red in color. The surrounding peri-ureteral tissue likewise was involved by inflammation. This ureter led to the stab wound in the left lower quadrant, and passed along the brim of the pelvis near the end of the left broad ligament and left ovary into the abdominal wall. At this point a drain entered the ureter, and this ureterostomy apparently had been functioning. On cut section the left kidney showed an acute purulent reaction in the pelvis, extending into all the calyces and into the parenchyma. The kidney itself was relatively large and soft. The capsule could be stripped. The demarcation between cortex and medulla was not clearly evident.

The right kidney was likewise greatly enlarged and was surrounded by perirenal fat showing inflammatory changes. This ureter was greatly enlarged and similar to the left ureter. The ureter below the drain was relatively small and contracted, and did not show the inflammatory reaction above noted (Fig. 12A and B). The sigmoid, when opened showed a tag of necrotic ureter extending into the lumen. Serial sections were made of this juncture because very

little could be made out grossly (Fig. 12). The right kidney was slightly larger than the left, weighing 300 grams, and showed all the changes found in the left kidney. In addition there were multiple, small, scattered cortical abscesses.

The parenchyma of the right kidney was distorted by a marked purulent inflammatory reaction extending up from the pelvis. There were many small scattered abscesses throughout the cortex and medulla. A few old scars of an arteriosclerotic nature were present. The acute reaction extended into the capsule. The cortical abscesses and the marked reaction were not seen in the left kidney but it showed an acute, gangrenous purulent pyelitis with the inflammation extending into the adjacent fat. The right ureter above the ureterostomy showed a zone of acute necrosis superimposed on a chronic inflammatory reaction, and there was an acute peri-ureteritis. This ureter below the ureterostomy was undergoing atrophy and necrosis probably of an infarcted nature. Serial sections were made showing the right ureter entering the sigmoid (Fig. 12). The ureter showed atrophy and necrosis, and at the point of entrance through the sigmoid, a subacute inflammatory reaction was found extending in all the coats of the bowel with a localized peritonitis. The formation of scar tissue had begun in this region.

SUMMARY AND CONCLUSIONS

The postoperative course of the first patient, and the perfect implantation on one side with normal ureter and kidney (Figs. 9 and 10) found at autopsy 8 months after operation in the second patient, encourage the belief that extraperitoneal drainage by ureterostomy and ureteral catheter in conjunction with implantation of the ureter into the bowel by the hidden perforating suture

TABLE I—3 PERSONAL CASES OF URETERO-INTESTINAL DIPLANTATION

Number of cases	Carcinoma of the bladder		Tuberculous cystitis		Vesicovaginal fistula		Ectrophy of the bladder		Hemorrhoids		Stricture	
	Dead		Dead		Dead		Dead		Dead		Dead	
	Dead	Living	Dead	Living	Dead	Living	Dead	Living	Dead	Living	Dead	Living
Method first method of C. C.	3											7
Second method of C. C.							1	1			11	1
Third method of C. C.												
Total	3	1					1	1			11	1
Time spent after birth											1	1

1. C. C. is a method by which bilateral implan-

tion would be made. The catheter gives free drainage until the suture cuts through. Opposed to this are the imperfect drainage and acute pyelonephritis which was present on the right side in the second patient and the finding at

autopsy of the acute ureteritis and the necrosis above the ureters only and of aneurysm infection below in the third patient, a complication which was apparently caused by the retention catheter. This method, therefore, cannot be recommended.

ANTERIOR GASTRO-ENTEROSTOMY BY THE SHORT LOOP METHOD

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PALLIATIVE operations often are indicated in cases of obstructive lesions of the stomach. Posterior gastro-enterostomy has long been the operation of choice in such cases. If its successful completion is not possible, however, some other method must be used. The classical anterior gastro-enterostomy is a poor second choice on account of the frequent complications which follow its use, namely obstruction and ulceration at the site of anastomosis or in the intestine near the anastomosis. Enterostomy in conjunction with anterior gastro-enterostomy lessens the possibility of obstruction but complicates the physiology of the intestinal tract and lengthens the operative procedure in a case which may be already a bad risk. We wish to present a short loop method of anterior gastro-enterostomy which offers the advantages of the posterior gastro-enterostomy and avoids some of the disadvantages of the classical anterior operation.

Recently in a case of an irremovable obstructive carcinoma involving the mid portion of the lesser curvature of the stomach we found that the lesion had extended into the posterior wall to such an extent that a posterior gastro-enterostomy was not possible. The anterior wall was free from infiltration. It was decided therefore to do an anterior gastro-enterostomy but to make the anastomosis through the mesocolon by a short loop method and thereby avoid the usual long loop which would have to be drawn anterior to the transverse colon.

The stomach was separated from the transverse colon by ligating the gastric branches of the gastro-epiploic arteries of the stomach in the gastrotocolic omentum. This opened the lesser peritoneal sac and freed a major portion of the greater curvature. The transverse colon was then drawn through the abdominal incision and an opening was made in the transverse mesocolon. The anterior wall of the stomach above the obstruction was drawn through the opening in the transverse mesocolon and one part of a light gastro-enterostomy clamp was applied. The stomach proximal to the clamp was sutured to the margins of the mesocolon so that after the colon fell to its normal position these sutures rotated the anterior wall of the stomach. In this way the portion which was superior was brought into a lower plane and the portion to be anastomosed was held

in the new position. The jejunum just distal to the ligament of Treitz was located and placed in the other portion of the gastro-enterostomy forceps. Then the antiperistaltic anastomosis was completed. The upper portion of the jejunum midway between the mesenteric and the antimesenteric border rather than the antimesenteric segment was the portion placed in the clamp. This avoided a rotation of the intestine in the axis of its lumen following anastomosis. Finally the anterior wall of the stomach above the anastomosis was sutured to the transverse colon along the line of the gastrotocolic omentum from which the greater curvature of the stomach had been separated.

The patient made an uneventful recovery. He had no nausea or vomiting and to date, 8 months after operation, has had no untoward symptoms. Deep X-ray therapy was instituted 3 weeks after the operation was performed.

The technique of the operation by steps is as follows:

1. An upper abdominal incision following the method advocated by Sloan is used.

2. The greater curvature of the stomach is freed from the transverse colon by ligating the gastric branches of the gastro-epiploic arteries directly below the chosen site of anastomosis, thus giving entrance to the lesser peritoneal cavity (Fig. 1).

3. The colon is drawn out of the incision, tensing the mesocolon which is opened between the colic vessels sufficiently to allow the anastomosis to be made.

4. The anterior wall of the stomach is sutured to the upper margin of the opening in the transverse mesocolon with interrupted chromic catgut sutures placed about three-quarters of an inch apart (Fig. 2).

5. The anterior wall of the stomach is drawn through the opening of the mesocolon and held by a light gastro-enterostomy clamp. Then the remainder of the opening in the transverse colon is closed by suturing it to the stomach proximal to the clamp.

6. The jejunum is located just distal to the ligament of Treitz and a short loop is placed in the anastomosis clamp in position for antiperistaltic anastomosis (Fig. 3A).

7. The anastomosis is closed by three continuous sutures of chromic catgut, the first layer

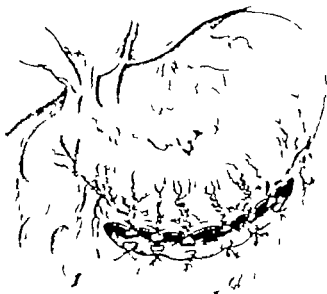


Fig. 1 Short loop anterior gastro-enterostomy. Opening into lesser peritoneal cavity through gastroduodenal omentum by ligation and section of gastric branches of gastro-epiploic arteries.



Fig. 2 Short loop anterior gastro-enterostomy. Suture of stomach to upper margin of opening in transverse mesocolon.

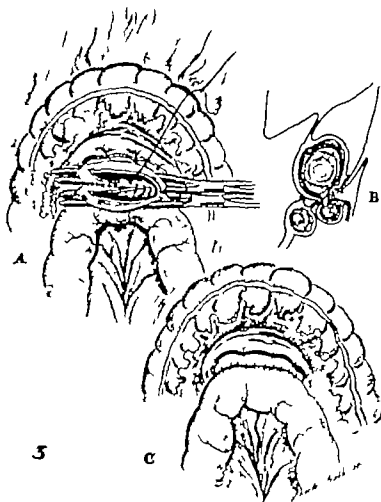


Fig 3 Short loop anterior gastro-enterostomy. A Short loop of jejunum placed in anastomosis clamp. B Relative position of jejunum to stomach after completion of operation. C Appearance of completed operation from below—similar to posterior gastro-enterostomy except that the anterior instead of the posterior wall of the stomach is anastomosed to the jejunum

including the serosa and the muscularis the second layer including the serosa muscularis and submucosa and the third layer including all three layers as an over-and-over haemostatic stitch (Fig 3 B and C)

8 The area on the colic side of the gastrocolic omentum first detached from the stomach is then sutured to the anterior wall of the stomach

9 The abdomen is closed without drainage

CONCLUSION

A technique for a short loop method of gastro-enterostomy is presented as a substitute for the

classical anterior gastro-enterostomy in those cases in which a posterior gastro-enterostomy is not technically possible

We believe that the method which is here presented offers the advantages of a short loop posterior operation and that it avoids the disadvantage of the possible complications which usually accompany the long loop anterior gastro-enterostomy

REFERENCE

- SLOAN, G. A. A new upper abdominal incision. *Surg. Gynec. & Obst.* 1927 45 678-687

MESENTERIC CYSTS¹

A BRIEF DISCUSSION AND REPORT OF THREE CASES

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PROBABLY the first cyst of the mesentery was described by Benivieni, a Florentine anatomist of the sixteenth century. He discovered the tumor at autopsy and recorded it as an anatomical curiosity. The lesion is sufficiently uncommon to arouse considerable interest whenever encountered. Possibly about 500 cases are recorded in the literature. In 1932 in a very fine review Warfield found a total of 129 reported cases since 1920. Carter in 1921 estimated that between 200 and 300 cases were recorded, while Flynn in 1930 thought the literature contained no more than 300 cases at the most. Judd states that in 820,000 admissions to the Mayo clinic hospitals, only 25 cases of mesenteric tumor were found and only 8 of these were cysts. Therefore in this clinic the incidence of mesenteric cyst was less than 1 per 100,000 admissions, while a tumor of some kind was found in the mesentery in 1 of some 35,000 cases. The Massachusetts General Hospital has a record of only 6 cases from 1900 to 1926. The University of California Hospital has a record of 1 cyst and 1 tumor of the mesentery in 93,511 admissions, since 1906. The Children's Hospital Los Angeles, has 3 cases recorded all in females, and all occurring in the last 3½ years, in a total of 12,425 admissions during the same period. Los Angeles General Hospital has a record of 1 case in 188,921 admissions in the last 5 years. Lane Hospital reports 3 cases from 1911 to 1933 in approximately 77,000 admissions. The New Harborview Hospital Seattle has no record of a mesenteric cyst in 27,000 admissions, and approximately 12 surgeons and pathologists in Seattle have no record of a case.

Warfield found in 129 cases the sex distribution as follows:

	Cases
Female	7
Male	37
Unknown	8
	29

Nine of the cases were in infants under 1 year of age and 21 were in children from 1 to 10 years of age. The age group from 30 to 40 showed the greatest incidence, 24 cases. I have encountered 3 cysts of the mesentery on my own service of

about 900 surgical admissions, during the last 2½ years or 1 in every 300 cases. Two were cases of intestinal obstruction, with the cysts as the etiological cause, and the other was a small cyst, possibly symptomless encountered during an operation for recurrent appendicitis. All occurred in males, all were undiagnosed before operation, and all were found in the mesentery of the ileum less than a meter from the ileocecal junction. In the literature, women seem to be affected about twice as often as men. Statements appear that the diagnosis is never made before operation. However correct pre-operative diagnoses were made by Haworth, 1920. Bertolini, 1921 and later by Alot in 1927 and Flauod 1930 and others.

The history of these cysts has been well divided into four periods: (1) 1707 to 1850 when the lesion was only discovered at autopsy (2) from 1850 to 1880 when an occasional cyst was operated upon, but there were no recoveries (3) from 1880 to 1900 when operation was beginning to be followed by a few recoveries and (4) from 1900 on when the condition was becoming definitely known, was more successfully treated, and occasionally diagnosed before operation. Possibly it is the rarest tumor of the abdomen. It may occur at all periods of life from infancy to extreme old age. Textbooks refer very briefly or not at all to the condition, and many surgeons of wide experience have never encountered a case.

The cysts may vary in size from less than a centimeter in diameter to truly huge tumors that fill the entire abdomen; thus they may be too large or too small to diagnose easily. About 70 per cent appear in the mesentery of the small bowel and the remaining 30 per cent are found in the mesentery of the large bowel or other mesenteries. Warfield's 129 cases were located as follows:

	Cases
Small bowel mesentery	61
Large bowel mesentery	50
Gastrohepatic mesentery	
Appendix mesentery	3
Unknown or unstated	5
	129

They are usually oval, round or bosselated, may be unilocular, bilocular or multilocular and

may be filled with chyle clear serous fluid, hæmorrhagic fluid clotted organized blood or other material. Some contain cholesterol crystals. Many times the walls are greatly thinned and any lining membrane the cyst may have possessed earlier has been destroyed through pressure atrophy. Likewise the entire wall may give no definite clue as to the origin of the lesion. Often times the contents are no more valuable as far as etiology is concerned.

DEFINITION

A true mesenteric cyst must occur between the leaves of the mesentery or under the serosa of the gut, and must not be a retroperitoneal cyst, although it may have originated from sequestered material which has migrated from retroperitoneal embryological organs to a position between the leaves of the mesentery. Cysts occurring retroperitoneally or under the peritoneum of the abdominal wall may have a similar origin but are not mesenteric cysts by location. Cystic malignant disease of the mesentery should be classified under malignant tumors as very rarely is there a record of a mesenteric cyst becoming malignant yet, Deaver suggests that such is a possibility as branchial cysts sometimes become malignant.

ETIOLOGY AND CLASSIFICATION

It seems impossible to determine accurately the etiology of many of these cysts, and so many classifications have been offered that the affair is confusing. Since quite a number occur in young children it is fair to assume that many of them are embryological in origin. A classification follows.

1. *Embryocystomata or embryonic inclusion tumors* (a) Those derived from sequestered remnants of the wolffian body or its duct, or the müllerian duct. In other words it seems possible that portions or remnants of the urinary or genital embryological organs could become detached migrate to a position between the leaves of the mesentery, retain or develop a blood supply, and develop into cysts. Pararenal cysts in all probability have origin from the wolffian body but nevertheless they retain their position near the kidney.

b Cystic dermoids and teratomata. The genital glands in both sexes develop behind the peritoneum as do other of the abdominal organs and the same theory holds true.

c. Dermal inclusions. This does not seem to account for many cysts although a dermal sebaceous cyst has been reported in the mesentery

by Swartley in 1927. Bartlett, in 1923 suggested this as an origin.

d. *Enterocystomata* or cysts developing from misplaced intestinal tissue. Here sequestrations from the intestine, fetal intestinal diverticula, or from the omphalomesenteric duct (vitelline) become displaced to positions between the leaves of the mesentery. In this manner cysts from intestinal remnants may occur anywhere along the digestive tract, while those from the vitelline duct occur principally in the mesentery of the ileum near its termination. Meckel's diverticulum represents the failure of the intestinal end of this same duct to become completely obliterated. Umbilical cysts may represent the failure to close of the other end of this duct. Miller reports a case of a 4 day old baby in which the wall of the cyst was, in one portion, directly continuous with the wall of the jejunum and the histological structure of the cyst wall resembled rather accurately the wall of the bowel. Here seems proof of a mesenteric cyst that owed its origin to sequestration or diverticulation of embryonic intestine. Minute intestinal diverticula and cysts are not infrequently found in rabbits.

2. *Chylous cysts* Ewing suggested that these cysts were chyle angiomata, which arose either from congenital or acquired obstruction to the mesenteric lymphatics and lacteals, carrying the chyle from the intestines to the receptaculum chyli. However Dowd thought that the chylous nature of some of these cysts was due to an effusion of chyle into a preformed cyst, especially since the very rich anastomosis of the mesenteric lymphatics seems to preclude that obstruction to even many channels would form a cyst.

3. *Bacterial or parasitic cysts* It seems possible that the necrosis and liquefaction in the enlarged mesenteric lymph glands of tuberculous, typhoid fever or bacterial infection of other nature might result in cyst formation. There is some evidence to support this. Parasitic, hydatid, or echinococcus disease has been responsible for cystic change in the mesentery.

4. *Traumatic cysts* These may be filled only with blood and result from operative or other trauma to the mesentery, resulting in hemorrhage between its layers with or without subsequent serous change. Genkin in 1928 reported a chylous cyst in the mesentery formed around a gauze sponge left in the abdomen during a previous operation.

5. *Angiomata of blood or lymph vessels* Very few cysts of the mesentery seem to be true lymph or hæmangiomata, and probably only a few cysts have this origin. However, in the past, competent

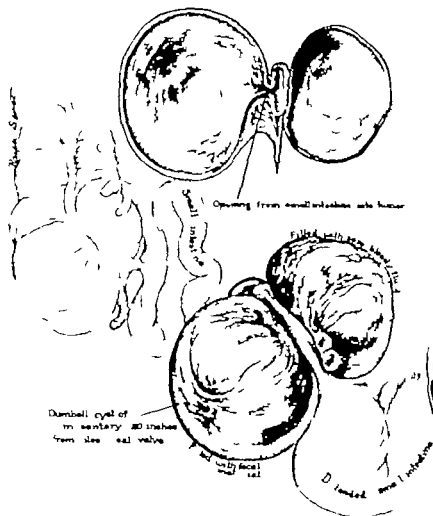


Fig. Case 1. Drawing of cysts as they appeared in the abdomen and also on cross section, showing the mechanism of the obstruction and the recent perforation of the ileum into one locule converting it into an abscess.

authorities have thought many of these cysts were a form of lymphangioma.

6 *Gas cysts*. Gas cysts are rare, usually symptomless, and nothing definite is known as to etiology. They may be multiple. Possibly they do not belong in a classification of this sort, as they seem fundamentally different.

SYMPTOMS

There are no definite pathognomonic findings applicable to the general run of cases. Most of them must be symptomless early in their development, and even until they are quite large, when the patient may note enlargement or a growth in the abdomen only. Usually the provisional diagnosis before operation is not correct.

However a rounded, freely movable, cystic, nontender abdominal mass, should suggest the possibility of a mesenteric cyst. According to several writers, the mobility is most striking in the transverse direction. Sometimes a belt of resonance can be percussed over the tumor where the intestine passes over it. Ruling out connections with the lumen of the bowel and other findings made with the barium meal or enema and fluoroscopy and films, should be valuable. Pressure from a cyst may give symptoms, depending upon which intra-abdominal organ it is encroaching upon. In one of my cases initial urinary symptoms were possibly caused by pressure of the cyst upon the urinary bladder. When complications arise the symptoms may be almost anything.



Fig. 2. Case 1. Wall of smaller locule (contents sterile) showing an organized granulation tissue and some large endothelial lined spaces.



Fig. 3. Case 1. Wall of larger locule (abscess due to intestinal perforation) showing inner surface which has a fibropurulent exudate.

are usually very pronounced and about 40 per cent of all complications are intestinal obstruction, either acute chronic, or intermittent in type. When acute complications ensue, the differential diagnosis would have to include almost every cause for the acute abdomen so varied may be the manifestations. It is well to bear in mind that an etiologically obscure but definitely acute abdomen should be explored without much wasted time. The main point, so far as the pre-operative diagnosis is concerned is to bear in mind the possibility of a mesenteric cyst.

PROGNOSIS

Atchley states the mortality to be 35 per cent for the cases as a whole. As previously mentioned intestinal obstruction brings about 40 per cent of the cases to medical attention and in this group the mortality is variously stated to be from 30 to 50 per cent. Warfield, in his 129 reported cases gives a known more or less immediate mortality of 20 per cent. In 23 of this series of cases the patient was able to leave the hospital but no follow up record was available. Of course the prognosis depends largely upon the time of diagnosis and operation type of operation found necessary size location attachments and complications present and the age and general condition of the patient.

COMPLICATIONS

These in the main are intestinal obstruction with or without gangrene of the bowel wall vol-

ulus (as present in one of my cases) intussusception adhesions or attachments to organs hemorrhage into a cyst, rupture of a cyst into the abdominal cavity rupture of the cyst into the bowel or vice versa causing acute inflammation and abscess formation in the cyst (as in another of my cases) perforation of an infected cyst with



Fig. 4. Case 1. Shows the granulomatous reaction in the wall of the small intestine near the perforation. The crystals represent cholesterol, probably due to inspissation or fat necrosis.

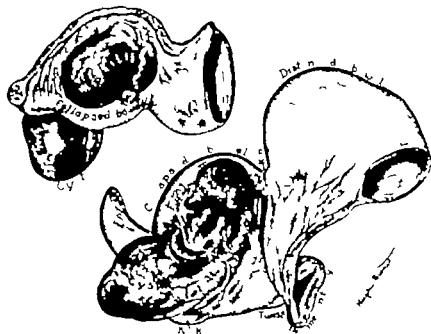


Fig. 5. Case 3. Showing tumor and volvulus and mechanism of the intestinal obstruction; also removed specimen.

peritonitis, ileus, and gastric dilatation and the complications that may ensue after abdominal surgery.

TREATMENT

This part of the subject seems to be rather definitely settled. The treatment is purely surgical, and in order of desirability is as follows:

1. Enucleation, if possible, without jeopardizing the viability of the gut by too much damage to its blood supply. This procedure is accompanied by about 9 per cent mortality.

2. Enucleation or resection accompanied by removal of a portion of bowel and anastomosis. Mortality is 25 to 30 per cent.

3. Manipulation or incision and drainage. This method should be used only when it is out of the question to do otherwise due to size, location, adhesions, or poor condition of the patient. The mortality is about 16 per cent. Cure is not always accomplished by this method and drainage persists for some months as a rule.

4. Aspiration seems to me to be a very unsatisfactory method of treatment. It has its place only as a means of diagnosis (with abdomen open) or to reduce the size of cyst preparatory to removal.

CASE REPORTS

CASE 1: Master A. P., white American boy aged 6 years, was referred to me on February 6, 1933, with the following history: He had pain in the right side of abdo-

men, nausea, vomiting and obstipation. The child had gone to school the previous day and returned home in the afternoon complaining of not feeling well all day. He complained of sharp pains all over abdomen, mostly in the right side. Nausea soon developed accompanied by vomiting, which continued throughout the night. A physician was consulted the next morning who diagnosed acute appendicitis and advised taking the child to the hospital at once. This was not done until 6:30 the same evening, after the child had been given castor oil and enemata, with no results other than to increase the pain and vomiting.

The past history was uneventful except for measles and for the fact that during the last 6 months at intervals of 3 or 4 weeks, the child had had sudden attacks of abdominal pain, with vomiting, lasting only a few hours, after which the child again felt perfectly well. The mother says the child was constipated before these attacks and that laxatives and enemata gave relief. She thinks he had no elevation of temperature.

Physical examination revealed a child acutely ill. He lay in bed with thighs flexed, and cried with pain if moved. The abdomen was moderately distended and on inspection it seemed to be more prominent in the right lower portion than elsewhere. The abdomen moved very slightly with respiration in the upper portion, and palpation determined the presence of a round, exquisitely tender, non-movable mass as large as a baby's head in the right lower quadrant. The right side of the abdomen was rigid, to such a degree that it was impossible to outline the mass accurately. It did not involve the kidney region. It could be felt by rectal examination. Except for evidences of dehydration, the rest of the physical examination elicited normal findings.

Laboratory examination of voided urine showed color amber, clear reaction, acid specific gravity 1.021; albumin and sugar negative; plus acetone; microscopic examination normal.

Blood examination showed hemoglobin 80 per cent Sahli, red blood cells, 4,700,000 white blood cells, 20,000 polymorphonuclears, 84 per cent.

Diagnosis (1) Abdominal tumor with intestinal obstruction and peritonitis (2) appendiceal abscess with obstruction and peritonitis

Operation. After adequate preparation the abdomen was opened, under nitrous oxide-oxygen-ether anesthesia. Dilated coils of intestine, a bloody serous exudate, which was cultured, and a bilocular cystic, bluish tumor arising from the mesentery of the ileum about 20 inches from the ileocecal valve, and freely movable, were found. The tumor was easily delivered into the wound. Each locule was the size of an orange, about 9 centimeters in diameter and one was covered with a glistening peritoneum and the other with a red inflamed peritoneum. The neck was broad and connected the two locules just under the mesenteric border of the gut in such a manner that the tumors so compressed the lumen of the ileum that almost complete obstruction existed. The appendix was normal.

An attempt was made to enucleate the tumors, but in so doing the inflamed locule was punctured in an area adherent to the intestine, through which the ileum had perforated into the cyst, forming an abscess within the cyst, and a few drops of foul smelling fecal material escaped. The rent was at once closed by suture and a resection of 3 inches of ileum cysts, and a V of mesentery done with end-to-end anastomosis following. Because of rupture during operation a small Penrose drain was inserted down to the anastomosis and the abdomen closed in layers. The patient made an excellent recovery. There was no vomiting, beyond the first 12 hours after surgery. Fluids were maintained by hypodermoclysis of normal saline and 5 per cent glucose retention enemata for the first 48 hours. The drainage from the abdomen was only moderate, the drain was removed on the third day after operation. The bowels were controlled easily with mineral oil. A temperature rise occurred on the sixth day after operation from a small abdominal wall abscess and on the twenty second day from an upper respiratory infection. Both were easily controlled. The patient left the hospital on the thirty-first day after operation, with the wound completely healed and the bowels regular without laxatives. He has been followed at intervals for over a year. It is growing rapidly, doing well in school and has no complaints of any kind. No incisional hernia developed.

Pathological diagnosis by Dr Edwin I Bartlett. Un differentiated cysts of the mesentery.

This tumor should have been easily movable but the acute abdomen and obstruction rendered the abdomen so spastic that this point could not be made out before operation. Had not the perforation into one cyst locule been present we probably could have performed the less dangerous operation of enucleation instead of resection with anastomosis of bowel. Probably the perforation occurred the day or night before operation, producing the fever leucocytosis and swelling in the cyst locule, and much more complete intestinal obstruction than the child had had with the previous attacks.

The contents of one locule were distinctly serous. The contents of the locule into which the gut had perforated were cloudy purulent, and fecal smelling. Cultures of this fluid gave abun-

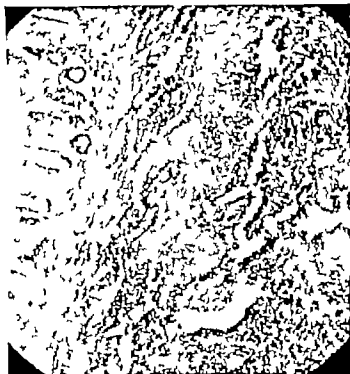


Fig 6. Case 2. Representative section of the cysts and also of the adjacent bowel, showing extravasated blood in the mesentery and extending to muscularis and mucosa of the damaged loop of bowel.

dant growth of intestinal organisms, while cultures of the other locule were negative. The contents were not chyle like. Because of the location this could have been a cyst originating from either an intestinal diverticulum or from the omphalomesenteric duct or from lymphatic ducts or lymphangioma.

CASE 2. Mr B C M, adult white male, single, aged 53 years, was admitted to the hospital at 2 15 p m on August 19, 1933. He had generalized intermittent abdominal pain, vomiting, obstipation, urinary difficulty and persistently distended abdomen for the past 48 hours. He began feeling ill 3 days ago and could not pass urine. He went to a doctor who catheterized him easily and obtained only a few ounces, after which he had been able to void small amounts. Since then he had not been seen by a physician until just before admission to the hospital. Two days ago the pain became worse and patient started to vomit. Several enemata and a laxative failed to move the bowels. He has had considerable abdominal pain of an intermittent character which he says extends over the whole abdomen and he thinks it is worse about the umbilicus and over the bladder region. He feels gas moving about in the abdomen and at these times the pain is most severe. He has vomited persistently for 48 hours and the bowels have not moved. He did not vomit any fecal smelling material.

Patient has always been well and strong except for a right inguinal hernia repaired 15 years ago and an appendectomy performed 12 years ago. The hernia has not recurred since and he left the hospital in 12 days after his appendectomy with the wound fully healed. He has noted a gradual increasing constipation for the last few years, but thought little of it. He has had no urinary difficulty whatsoever until the present illness.

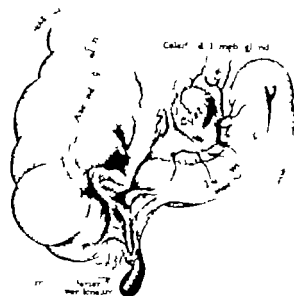


Fig. 7. Case 3. Drawing showing the size and location of the cyst, the two calcified mesenteric glands and the appendix.

The family is negative as far as the present illness is concerned.

Physical examination. Patient is obviously very ill. The skin, tongue and mucous membranes are dry and delirious pulse 94 per minute, temperature 99.8 degrees F. and respirations 24 per minute. The heart seems slightly large to percussion and a non-transmitted murmur is heard at the apex. Tonal quality is good and there is no evidence of decompensation. Blood pressure is 124/72. Patient vomited about a pint of bile stained foul stomach contents during the examination. The abdomen is greatly distended and tense, the percussion note is tympanic throughout. There is moderate tenderness and muscle spasm over the lower abdomen, and no masses or organs are palpable, owing to the distention. With the stethoscope an occasional peristaltic movement can be plainly heard, corresponding to the patient's spasms of pain. The bladder is not distended. Catheterization is easily done and yields about 5 ounces of clear dark urine. The rectal examination reveals what appears to be distended coils of gut deep in the pelvis or a soft, only slightly tender mass. The prostate is small and sphincter tone good. The rest of the examination revealed nothing of note.

Laboratory examination showed the urine dark, clear in color, specific gravity 1.028, reaction, neutral, trace of albumin, no sugar, plus acetone. Microscopic examination showed an occasional hyaline cast, occasional pus and epithelial cells. The specimen was centrifuged.

Blood examination showed white blood cells, 8,000, red blood cells, 4,600,000.

Diagnosis. Acute intestinal obstruction, probably from adhesive bands about terminal ileum from previous laparotomy.

Procedure. Patient was put to bed, and several hours were spent preparing him for operation. He received 500 cubic centimeters of salt solution subcutaneously, enemas, without results, stimulants and gastric lavage. Under low spinal anesthesia laparotomy was performed. The entire abdomen was filled with tense, distended coils

of ileum, quite reddened in appearance, so we determined that the obstruction was quite low down. Inserting the hand into the pelvis a tumor mass was found deep down against the bladder and feeling cystic and lobulated. It was easily delinked into the wound. The tumor was seen to be a multilocular cyst of the mesentery of the ileum, about 24 inches from the ileocecal junction, 4½ times 2½ inches in diameter and with the cyst locules very closely encroaching upon the gut and one or two bulging past the antimesenteric border. There was complete volvulus or torsion of the cyst and involved intestine, i.e. one twist of the mesentery causing a complete intestinal obstruction and a pregangrenous condition of the involved gut. Fortunately the adhesions were not tight and very little of the mesentery was hemorrhagic and thrombosed. The distended coils of gut were so in the way that an ileostomy was done 8 inches above the obstruction, using a No. 6 catheter and by very gentle suction a great deal of liquid material and gas was removed. Resection of the cysts, about 5 inches of bowel and the injured mesentery was done followed by an end-to-end anastomosis. The abdomen was closed in layers about a small drain and the ileostomy tube.

The patient was returned to the ward in fair condition, blood pressure 100 systolic and fully conscious and rational. The ileostomy tube was allowed to drain every alternate hour the patient was digitized, 3000 cubic centimeters of normal saline was given subcutaneously per 24 hours and 300 cubic centimeters of 5 per cent of saline given intravenously the first 3 or 4 days. Retention enemata of 6 ounces of 5 per cent glucose were given every 4 hours. (Not only does this last supply fluid, but the irritation it causes in the lower bowel stimulates peristalsis higher up, and is of material aid in the after-care of a case of this kind.) There was considerable purulent drainage from the abdomen, and the drain was shortened daily and removed completely the fifth day after operation. The bowels were moved daily with a small enema. The first bowel movement unaided by an enema occurred on the sixteenth day after operation. The ileostomy tube was clamped off permanently on this day and was removed on the nineteenth day after operation. The fistula closed rapidly and the patient left the hospital on the twenty-eighth day after operation with his wound completely healed except for a non-draming granulating area at the site of emergence of the catheter. His general condition was good and his bowels were moving well on ½ ounce mineral oil twice daily. He was seen a week later feeling fine, wound completely healed, appetite and bowels were normal. This patient was last seen on December 20, 1933, about 3 months after operation when he had gained about 20 pounds in weight, and his bowels were regular without laxatives or mineral oil. He had no complaints.

Probably this cyst resulted from trauma to the mesentery possibly during the appendectomy 12 years previously. There is no history of other abdominal trauma. There is no proof that it is a hemangioma.

Diagnosis by Dr. Edwin I. Bartlett. blood cysts of the mesentery.

CASE 3. Mr. L. H. M., white American male, aged 46 years, was admitted to the hospital March 25, 1933. Patient complained of pain and discomfort in the right lower abdomen, at intervals for the past 3 years. About 2 years ago the patient began to be conscious days at a time of pain of an aching character in the right lower quadrant, aggravated by eating and working. He sometimes felt nauseated, but never vomited. After a few days the pain would leave and not occur for 2 or 3 weeks. The last few months the condition has been worse and he comes to the hospital for relief. There is no gall bladder pain, no ulcer

history no urinary symptoms, and the pain does not radiate. Patient admits having syphilis in 1906. He was treated at intervals until 1919 and since then the Wassermann reaction every year has been negative. No gonococci were noted. He has never been ill otherwise. He has always been a native of California.

The family history is negative for tuberculosis or chronic disease.

Physical examination temperature, pulse, and respiration were normal. Head and neck were negative, heart and lungs normal. The blood pressure was 130-84. The abdomen was flat, moved well with respiration, there were no organs or tumors palpable, and no rigidity, but very definite point tenderness to deep palpation over the appendiceal area. Rectal examination revealed only a few small hemorrhoids, a slightly enlarged prostate and good sphincter tone.

A plain film of the abdomen revealed normal kidney shadows, and in the appendiceal area and above the brim of the pelvis were two shadows, like stones, 3 by 1 and 1 centimeter in diameter, respectively. A barium enema revealed a normally filling and appearing large bowel, a competent ileocecal valve, and a poorly filling appendix which was not very movable and was very tender to deep palpation. The two shadows observed in the plain film, were seen about 3 inches above and a little medial to the appendix, and were freely movable, and not tender. We thought they were calcified mesenteric glands.

Spinal fluid and blood Wassermann reactions were negative. The urine was negative, the hemoglobin 82 per cent. Salih, red blood cells, 4,600,000 white blood cells, 6,900.

Diagnosis recurrent appendicitis, calcified mesenteric lymph glands.

Operation revealed a short, bulbous, chronically inflamed appendix, adherent to the cecum and ileum. The two shadows were found to be calcified lymph glands in the mesentery of the ileum about 3 or 4 inches from the ileocecal junction, one near the root of the mesentery the other nearer the gut. Between the two was a thin walled cyst, of the mesentery about 3 centimeters in diameter. The glands and appendix were removed. The cyst was shelled out, but in so doing the very thin wall ruptured, a colorless thin fluid escaped and the wall was subsequently lost, so that we were unable to study it. Convalescence was uneventful. The patient was discharged on the eleventh day after operation. He was last seen March 6, 1934, almost a year after operation. He has had a complete relief of symptoms. Crushed sections of the nodes revealed nothing but calcium. Pathological diagnosis of the appendix was normal. Only one cross section was examined, and the organ was not normal grossly. This cyst might have resulted from liquefaction of an infected lymph node, especially since on either side was a calcified node. Could the appendix have caused the lymphadenopathy? No other cause was found.

SUMMARY AND CONCLUSIONS

The first cyst of the mesentery was found at autopsy in the sixteenth century. The history of the tumors is divided into four periods. Possibly four or five hundred cases have been reported in the literature. It is probably one of the rarest of abdominal tumors. The etiology, correct classification and pathology are obscure. The mortality rate is higher than it should be and the diagnosis is uncertain before operation both

should be improved. Possibly if we would bear in mind the possibility of mesenteric cysts in obscure abdominal lesions we would diagnose more cases before operation. Complications are disastrous as a rule, often give the first symptom and thus obscure and cloud the diagnosis. Uncomplicated cases, and most cases taken early should have a relatively low mortality. Three personal cases are reported fully. All recovered. Two are known to be alive and perfectly well more than a year after operation, and the third was doing very well when last seen 3 months after surgery. Two of the cases were obscured by grave and serious complications and the third was a small cyst, possibly symptomless. The etiology was not determined exactly in any case. A possible classification of these lesions is presented. The subject is extremely interesting from the standpoint of etiology, symptomatology and diagnosis, and it should be emphasized that it be considered more often in the differential diagnosis of intra abdominal disease.

BIBLIOGRAPHY

1. ALLESTON L. A. Mesenteric chyloous cysts. *Calif & West Med* 1929 30 261-262.
2. ALON Reform. m d 1927 43 1011.
3. ATCHLEY R. Q. Mesenteric cysts. *J Oklahoma M Ass* 1929, 22 125-129.
4. BALDWIN J. F. Huge fibroma of mesentery resection of 6 feet of jejunum recovery. *Am J Surg* 1927 2 160-161.
5. BARTLETT E. K., and HEUTER. *J Lab & Clin Med.* 1926 13 427-430.
6. BERTOLINI A. H. *Maggiore*. 1st ed. vol. 9, p. 278. Milano 1931.
7. CANNON D. J. and O'KELLY W. D. Solid tumor of the mesentery (teratoblastoma). *Irish J M Sc* 1925 571-573.
8. CARTER, R. M. Cysts of mesentery. *Surg Gynec. & Obst.* 1921 33 544-548.
9. CHANEY, R. H. Mesenteric cysts with intestinal obstruction. *J Med Ass Georgia*, 1929 18 517-520.
10. COLLINS, ARTHUR N., and BERDIZ, G. L. Chyle cysts of mesentery. *Arch Surg* 1934, 38 325-334.
11. COURELLAR, V. S., and COX, F. W. Fibroma of mesentery report of case. *Surg Clin N America*, reprint, 1933.
12. CRAKE, W. Lymphangioma of mesentery. *Am J Surg* 1930, 9 441-443.
13. DECOURY J. L. and MALONEY J. J. Fibromata of mesentery. *Surg Gynec & Obst* 1925 40 402-403.
14. DOWD Ann Surg 1900, 32 515.
15. DUTTON F. K. Report of case of ruptured chyloous mesenteric cyst case report. *New England J Med* 1930, 203 1033-1034.
16. FISHER Polichin sez. chir 1930, 37 506.
17. FISHER, W. H. Mesenteric tumors. *Am J Surg* 1929, 7 803-804.
18. FRIEND E. Mesenteric chyle cyst. *Surg Gynec & Obst* 1912 15 1.
19. HAWORTH. *Lancet*, 1920 1 1269.

- 30 HERRICK, W. Mesenteric enterocystomata. *J Lab & Clin Med*, 1927, 12, 427-430.
- 31 JACKSON, A. D. and EWELL, G. H. Chylous cysts of mesentery with case report. *Wisconsin M J* 1929, 28, 364-365.
- 32 JONES, T. M. HOWARD, M. A. and FRINGSBROW, J. H. Chylous cyst of mesentery. *Northwest Med* 1930, 29, 123, 125.
- 33 JUDS, E. S. and CUSTER, N. W. Primary tumors of the mesentery. *Proc Staff Meet. Mayo Clin* 1932, 7, 555.
- 34 JUDS, E. S. and HELMOLD, O. C. Mesenteric cysts. *Surg Clin N America*, 1920, 2, 849-855.
- 35 JUDS, E. S. and McVAY, J. R. Fibromata of mesentery. *Surg Gynec & Obst* 1920, 3, 372-375.
- 36 LANG, W. H. Two cases showing unusual surgical affections of the mesentery. *Canadian M Ass J* 9, 3, 17, 573-576.
- 37 LEE, A. E. Mesenteric cyst simulating acute post partum dilatation of stomach. *Med J Australia*, 1927, 83-85.
- 38 McCALLA, L. H. Fibromata of mesentery with case report. *J South Carolina M Ass* 93, 23, 2 - 212.
- 39 NIOSI. *Arch f path Anat* 1907, 190, 217.
- 40 NIXON, J. and GUERRELL, J. D. Mesenteric cyst in child. *J Am M. Ass* 1933, 100, 1330.
- 41 PETERSON, E. W. Multiple cyst of mesentery. *Am J Surg* 1928, 5, 514-516.
- 42 RANKIN, F. W., and Major, S. G. Tumors of mesentery. *Surg Gynec & Obst*, 1932, 54, 809-817.
- 43 SHALLOW, T. A. Entero-mesenteric cysts. *Ann Surg* 1925, 81, 795-800.
- 44 SHOWNON, H. J. and WELLS, L. Case of entero-mesenteric cyst simulating acute retention of urine. *Lancet*, 1932, 1, 181.
- 45 SOLONOV, B. Fibrosarcoma of mesentery. *Surg Gynec & Obst*, 1918, 27, 154-155.
- 46 SONNICKS, J. E. Solid pure fibroma of mesentery in children. *Surg Gynec & Obst* 1932, 4, 244-245.
- 47 WAGGENTRICK, O. H. Remarks on (1) suppurative thrombophlebitis and (2) mesenteric cyst. *Minnesota Med* 1923, 16, 146.
- 48 WADE, R. B. and STRICKLAND, J. Case of mesenteric cyst. *Med J Australia*, 1923, 1, 465.
- 49 WARFIELD, J. O. Jr. Study of mesenteric cysts. *Ann Surg* 1932, 129-339.
- 50 WILSON. *Brit M J* 1929, 1, 103.

TERATOMA OF THE SPINAL CORD¹

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TERATOMATA of the spinal cord are among the rarest of tumors. The following case in which such a tumor was found is of casual interest because of the difficulty in differential diagnosis which it presented and because it so clearly illustrates the amazing ability of the spinal cord of a child to recover from severe compression.

CASE REPORT

R. B., onset with irritability and anorexia at 16 months of age, slowly developing paraplegia with pain in left ankle examination revealed a paraplegia without sensory change, lumbar puncture demonstrated a complete subarachnoidal block with From's syndrome. Lipiodol injected roentgenographic changes in lower dorsal and lumbar spine, operation at 2½ years of age removal of teratoma of spinal cord recovery.

R. B., unit No. 83815 male, was born on June 30 1931. He was referred by Dr. R. W. Carpenter of Geneva, Illinois, and first admitted on the pediatric service of the University of Chicago Clinica on June 8 1933 with complaints of "failure to gain weight and weakness of the left leg."

This child was the last of four pregnancies. The first pregnancy terminated in a premature birth, the infant died shortly thereafter. The second child was a "blue baby" and is at present alive and apparently well (although not examined) at 6 years of age. The third pregnancy terminated in an abortion. The remainder of the family history has no obvious relation to the condition of this child. R. B. was normal at birth and weighed 7 pounds, 4 ounces. Except for an attack of impetigo shortly after birth his infancy was uneventful. He walked at 1 year of age and weighed 21 pounds. There were no other illnesses.

In the latter part of October 1932 (age 16 months) he began to cry more frequently, became very irritable and it was difficult to get him to eat. At about the same time it was noted that the neck was becoming stiff. This persisted for about 6 weeks. He had no fever, there was no vomiting or diarrhea. This illness continued unchanged and in November he was confined to bed where he remained until March, 1933. During this period he was unable to raise his legs, but in March he began to stand and walk a little with aid. He complained that he did not want to ride in an automobile because "something hurts me," and he complained of pain in the back on being moved. He was told to have continued to improve but when first seen in June 1933 he was unable to stand or walk alone. He no longer cried and seemed much less irritable. In a note Dr. Carpenter stated that he had noted a weakness of the left leg which had first appeared a short time after the onset of the illness in October.

Examination on June 8 1933 revealed a very thin, pale child. He seemed quieter than a normal child of his age. Except for the malnutrition the chest and abdomen seemed entirely normal. Neurological examination revealed no abnormalities of the cranial nerves, the upper extremities seemed quite normal but the left leg showed slight generalized wasting, particularly in the gastrocnemius and gluteal muscles. The left foot was everted. There was also definite weakness of the left lower extremity. The tendon reflexes of the upper extremities were diminished but equal. In the

lower extremities the knee jerk was less active on the left than the right and the left Achilles tendon reflex was absent whereas it was present on the right. The abdominal reflexes were present and equal on the two sides. Babinski's sign was not present. No sensory disturbance could be found.

At that time the child weighed 9 kilograms (19.8 pounds). Laboratory examination revealed a normal urine, a blood count of 5,000,000 erythrocytes, 8,000 leucocytes, and 78 per cent hemoglobin. The Wassermann and Kahn tests on the blood were negative, as was the test with tuberculin of 1:1000 dilution. Roentgenological examination was made of both lower extremities, the pelvis, the lower lumbar spine and sacrum, and the stomach. All were reported as normal.

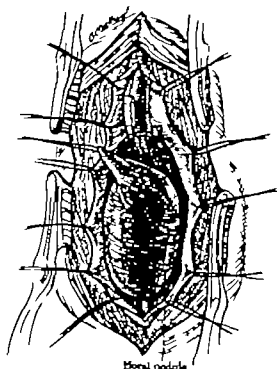
It was felt that his condition was the result of an acute anterior poliomyelitis. The parents were given instructions as to diet and physiotherapy and the patient was discharged.

On January 15 1934 the mother wrote that the child had improved slightly, had a better appetite, and had gained a few pounds. However in December 1933 he had



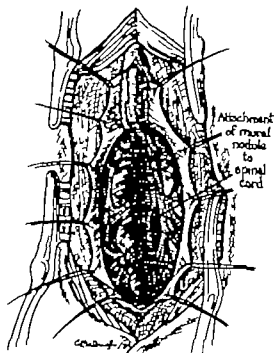
Fig. 1. Lateral roentgenogram of the lower thoracic and lumbar spine. The lipiodol arrested at the upper border of the eleventh thoracic vertebra is seen above. The anteroposterior diameter of the spinal canal is greatly increased at the level of the first, second and third lumbar vertebrae as compared with the normal canal at the fourth and fifth lumbar vertebrae. The pedicles of the first lumbar vertebra are decalcified.

Fig. 2. Anteroposterior view of the spine. The lipiodol resting upon the superior curved surface of the tumor is present above. The canal from the twelfth thoracic to the third lumbar inclusive is grossly widened in fact it is wider than the bodies of the vertebrae at this level. The pedicles of the twelfth thoracic, first, second and third lumbar vertebrae particularly the middle two are markedly flattened as compared with the normal pedicles of the fourth and fifth lumbar vertebrae.



Mural nodule

Fig. 3. Drawing of tumor made at the operation. The spinal canal is grossly dilated. The cyst has been drawn to one side and rotated so as to reveal the flattened spinal cord beneath it and the mural nodule in its lower part which was attached to the spinal cord.



Attachment of mural nodule to spinal cord

Fig. 4. Drawing of spinal canal after removal of tumor showing the dilatation of the canal and the severe compression of the spinal cord and its roots. The defect in the posterior columns from which the mural nodule was removed is shown.

begin to complain of "severe pains in the left leg, particularly in the region of the ankle. These pains occurred repeatedly both day and night and were aggravated by using the leg. It had also been noted that lately there had been periods of infrequent urination. This was the first evidence of any involvement of bowel or bladder.

Re-examination. Because of this new development the child was seen in the out-patient department on January 30, 1934. His weight was 10.3 kilograms (22 pounds, ounces). The lungs, heart, and abdomen seemed perfectly normal. The left leg seemed stronger than it had been. The knee jerks were both absent as was the ankle jerk on the left. No sensory loss could be detected. During the examination the patient suddenly cried out with severe pain in the left ankle. This persisted for about 10 minutes. During this time mobility of the leg remained unchanged. Subsequently the left lower extremity was "cold and clammy" while the right remained warm and dry. The mother stated that she had repeatedly observed the same change following similar attacks of pain.

Röntgenograms were made of the hips and pelvis but these were reported as normal.

The child was again returned to his home. On February 19, 1934, Dr. Carpenter wrote that the child seemed more emaciated than ever and was suffering greatly from the attacks of pain.

Road mission. On March 19, the child was readmitted to the clinics. The parents stated that the pains had gradually grown more severe until February 20, when the child had suffered a particularly bad attack. Following that a rash had appeared on the leg which according to the family

physician followed "the nerve. The rash soon disappeared and subsequently he was practically free from pain, but developed a swelling on the external margin of the left foot.

His weight at this time was 9.6 kilograms (21 pounds, ounces). The general physical examination except for the emaciation was negative. Neurological examination revealed weakness of both lower extremities, especially the left, absence of all tendon reflexes in the legs, wasting of the entire left lower extremity, rigidity of the lower back, and no sensory disturbance.

On March 26 a lumbar puncture was performed. The spinal fluid was deep amber in color and coagulated on standing.

Röntgenograms were made of the vertebral column from the seventh cervical vertebra to the coccyx and were reported as normal.

On April 4, under ether anesthesia, the distena magna was punctured and cubic centimeter of lipiodol injected. Subsequent roentgenograms revealed that the lipiodol had descended the spinal canal to the level of the eleventh thoracic vertebra where it was completely arrested by a dome shaped mass (Figs. 1 and 2). With this additional information a review of this and previous roentgenograms revealed a gross dilatation of the spinal canal from the twelfth thoracic to the third lumbar vertebra inclusive, in both the lateral and anteroposterior diameters. There was visible a distinct flattening of the medial surfaces of the pedicles of these vertebrae with definite narrowing of their transverse diameters. In the lateral view, it was obvious that the pedicles, particularly those of the first lumbar vertebra were markedly declassified.

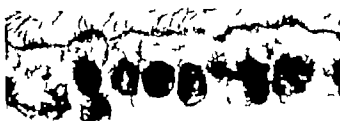


Fig. 5. Epithelial lining of the thin cyst wall. It is composed of a single layer of cuboidal epithelium. Hematoxylin and eosin. $\times 1310$.

The child was again examined on April 9, at which time the upper extremities were normal. There was marked rigidity of the neck and entire back. The spinous processes of the ninth thoracic vertebra seemed unduly prominent but because of the severe emaciation all of the spines were very distinct. There was definite tenderness of the lower thoracic and lumbar regions posteriorly. The abdomen was somewhat distended but no localized weakness could be detected. All abdominal reflexes were active. The cremasteric reflex was present on the right but absent on the left. There was definite atrophy and weakness of both lower extremities. All movements were possible but weak. The patient was unable to stand even when grasping the sides of his bed but could sit up unaided. The right knee jerk was fairly active but the left was absent. Both ankle jerks were present and ankle clonus was elicitable on the right. Babinski's sign was positive bilaterally. There was definite flaccidity especially of the left lower extremity. No sensory loss to pin prick, cotton, vibration or sense of position could be detected. Marked persistent erection of the penis was present throughout the examination and was repeatedly observed thereafter.

It seemed definite from this examination that the lesion of the nervous system which was previously manifest by weakness, atrophy and loss of tendon reflexes had now extended to a higher level in the spinal cord as shown by the hyperactive reflexes, clonus, and the presence of Babinski's sign.

Diagnosis. With the aid of the lumbar puncture and X-ray findings a diagnosis of a large tumor of the lower spinal cord and cauda equina was made.

Operation. April 10, 1933. Under ether anesthesia the spaces and laminae of the eleventh and twelfth thoracic and upper four lumbar vertebrae were exposed and resected. The laminae of the twelfth thoracic and upper three lumbar vertebrae were extremely thin and had been pushed far posteriorly greatly reducing the length of the spinous processes. The spinal canal was dilated to two or three times the normal size (Figs. 3 and 4). The dura mater was thin and translucent. Within it was found a large thin walled cyst which lay beneath the arachnoid (Fig. 3). This cyst extended from the eleventh thoracic to the upper border of the fourth lumbar vertebra. It was filled with a very thick tenacious, glary opalescent material which jelled when exposed to the air. The cyst was slowly dissected from the spinal roots which lay on either side and the spinal cord which was beneath, i.e. anterior to it. It was impossible to remove the cyst intact so the contents were evacuated (35 cubic centimeters, 38 grams) and the entire cyst removed. In the lower part at the level of the third lumbar vertebra, there was an elongated bean-shaped solid nodule measuring about 1.5 centimeters by 0.5 centimeter in the anterior wall. This was the only point at which the tumor was



Fig. 6. Section through the entire thickness of the teratomatous mural nodule. A. Stratified cuboidal columnar epithelium lining the cystic cavity. B. mucous glands. C. adipose tissue. D. hyaline cartilage. E. posterior columns of the spinal cord. Hematoxylin and eosin. $\times 15$.

attached to the surrounding structures. Here entered all of its vascular supply. This nodule was firmly attached to the posterior surface of the spinal cord about 1.5 centimeters above the tip of the conus medullaris. It was carefully removed from the spinal cord by blunt dissection.

After the tumor was removed (Fig. 4) one could see the roots of the cauda equina lying against the wall of the dilated spinal canal and the spinal cord which had been flattened to a thin ribbon lying on the anterior wall of the canal. The tip of the conus medullaris extended almost to the lower border of the fourth lumbar vertebra. In the midline of the posterior surface of the lower end of the spinal cord was a defect from which the tumor had been dissected. The wound was closed without drainage.

Postoperative course. Following the operation the patient was incontinent but his recovery was otherwise uneventful. He was discharged on April 24, 1934, 14 days after operation. At that time examination revealed good strength in all muscles of the lower extremities except for those concerned with movement of the left foot, in which strength was only fair. Reflexes were normal except for increased ankle jerks with ankle clonus bilaterally and a positive Babinski's sign on the right. There was no sensory loss. The child was able to stand when grasping the sides of his crib-bed. Two weeks later on May 8 the child was seen in the out patient department. The change in his condition was striking. His parents stated that whereas before they had had great trouble getting the child to eat, each meal requiring about 2 hours, he now ate readily and demanded more as well as having to be fed between meals. He no longer suffered from any pain. He slept very well. The child's face was fuller, and his color good in contrast to his pale, pinched expression before operation. He was able to

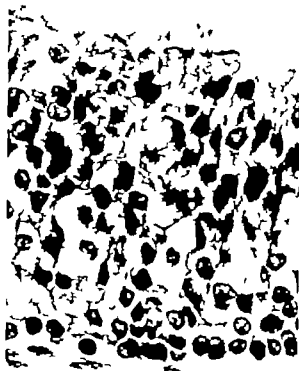


Fig. 7 Stratified ciliated columnar epithelium which covered the inner surface of the mural nodule. There are many large goblet cells. Hematoxylin and eosin $\times 800$.



Fig. 8 Mucous glands from the mural nodule. Hematoxylin and eosin $\times 302$.

stand without aid and to walk with very little assistance. There was no longer any trouble with either bowel or bladder. When last seen on June 5, 1934, the patient was able to walk quite well without any assistance.

*Microscopical examination.*¹ The wall of the cyst and the mural nodule were fixed in formalin, sectioned serially stained with hematoxylin and eosin and impregnated by Freeman's silver technique for nerve fibers and Perls's method for reticulum.

The cyst wall consisted of two parts, a loose vascular connective tissue which covered its surface and a lining epithelium. In many places this epithelium was composed of a single layer of low cuboidal epithelium (Fig. 5). Elsewhere it was two to three cells in thickness. Upon the inner surface of these cells were many cilia.

The mural nodule was much more complex (Fig. 6). It consisted of two portions between which there was no sharp line of cleavage. That portion of the nodule nearest the cyst cavity was composed of teratomatous tissue. On its surface was a thick layer of ciliated stratified columnar epithelium in which many goblet cells could be seen (Fig. 7). Lying beneath this epithelium was a loose connective tissue in which were embedded many pieces of hyaline cartilage. Lying in close relation to the cartilage in a manner strongly suggestive of the trachea, were found nests of glands (Fig. 8). It was the opinion of Dr. R. R. Bensley of the Department of Anatomy that these glands were mucous in type and most closely related to those normally found in the posterior part of the palate, although they bore some

resemblance to those of the trachea. These glands were connected by several ducts to the interior of the cystic cavity into which they presumably poured their secretion. In this same area were found bundles of myelinated nerve fibers (Fig. 9). Through the serial sections these could be traced to their origin from a small group of large multipolar ganglion cells at one end of the mural nodule (Fig. 10). There were also areas of adipose tissue (Figs. 6 and 9) and several isolated collections of lymphocytes. Tissue which could be definitely identified as muscle could be seen.

That portion of the nodule farthest from the cystic cavity and in close contact with the spinal cord consisted primarily of a great number of longitudinally arranged, parallel nerve fibers which were best shown by Freeman's technique of silver impregnation for nerve fibers (Fig. 11). In places these fibers were closely crowded together; in others they were more sparse. Not all of them were normal, many being swollen and fragmented, while others possessed degenerative end-bulbs and end-loops. In places where the nerve fibers were few there was a proliferation of glial tissue. It was felt that most probably this area was a portion of the posterior columns of the spinal cord which was intimately connected with the teratoma and had been removed with it. This was regarded as particularly likely because of our inability to demonstrate any neurocytes from which these nerve fibers might have arisen. Those few ganglion cells which had been found were definitely related to the bundles of myelinated nerve fibers found in the more superficial parts of the tumor. At no point was there any evidence of any connection or relationship of the tumor or the cyst to the ependyma-lined central canal of the spinal cord.

Portions of the gelatinous contents of the cyst were fixed in various fixatives, embedded, and stained with hematoxylin and eosin. Microscopical examination revealed no definite cells. There were a number of large indistinct eosinophilic cytoloid bodies. These were entirely devoid of nuclei. The gelatinous material itself presented a uniformly finely granular eosinophilic appearance.

NATURE AND GENESIS OF THE TUMOR

This tumor undoubtedly comes under the classification of teratoid or bilaminar tumors. As Hoen

¹ We are deeply indebted to Dr. George Bartschman of our Department of Anatomy who very kindly assisted us in the microscopical examination of this tumor.



Fig. 9. Section from the mural nodule showing bundles of unmyelinated nerve fibers, *C* in the neighborhood of the, *A* hyaline cartilage *B* mucous glands and *D* adipose tissue. Freeman's method for nerve fibers. $\times 215$.

pointed out, this is true for all examples of intradural teratoma. And as has been true in all other instances the germinal layer not represented in the various structures which compose this tumor is the entoderm. All the structures present would be classified as arising either from ectoderm (ciliated stratified columnar epithelium ciliated cuboidal epithelium mucous glands, ganglion cells unmyelinated nerves) or mesoderm (cartilage adipose tissue, connective tissue). Such teratomatous neoplasms as this are probably not to be explained by a simple mechanical embryological malformation such as gives rise to dermoid and epidermoid cysts, or the congenital dermal sinuses recently reported by Walker and Bucy. In these, simple inclusion of a portion of the surface ectoderm in the underlying mesodermal tissues gives rise to a neoplasm or malformation composed solely of proliferated epidermis and dermal structures. This complex teratomatous neoplasm composed of elements largely devoid of any embryological relationship to the nervous system or its anlagen probably arose from a maldevelopment of the ovum the misplacement of some multipotential germinal cells early in embryonic development, forming as Bucy and Haymond have pointed out for another similar tumor a twin which had not gone on to full development. It would seem that the explanation most favored by Kubie and Fulton that these cysts probably represent ependymal diverticula of the central canal of the spinal cord is an entirely inadequate explanation because of the lack of demonstrable relationship between the ependyma and such structures as cartilage fat tissue, and mucous glands.

DISCUSSION OF THE CLINICAL ASPECTS

This case again demonstrates the value of lumbar puncture in cases of obscure diseases of the spinal cord. It is also illustrative of the point that the diagnosis of anterior poliomyelitis is particularly to be questioned when the manifestations are somewhat unusual or the disease is progressive. In the present case suspicion that the diagnosis which had been made was incorrect was first raised with the appearance of subjective pain. The pain can in all probability be attributed to irritation of the posterior lumbar nerve roots although the possibility that it was secondary to intense vascular spasm must be considered especially so as the attacks of pain were followed by a localized vasoconstriction which was manifested by the left lower extremity becoming cold and clammy. These attacks may have been due to irritation of the vasoconstrictor nerve fibers arising from the spinal cord. However it is generally conceded that the efferent nerves to the sympathetics arise only from the thoracic spinal cord whereas the tumor in this case was limited largely, if not entirely to the lumbosacral portion of the cord. It is true that Oughterson Harvey, and Richter have presented evidence of some vasoconstrictor fibers arising from the lumbosacral cord but it is questionable if irritation of these few fibers alone would have given rise to such severe vascular spasms. The attacks of course may have been elicited in some obscure reflex manner. The relationship of the pain and the vasoconstriction to the rash which subsequently developed is also not clear. This rash was presumably of the nature of a herpes zoster. And although the pathogenesis of



Fig. 10. Ganglion cells found at one end of the teratoma. The myelinated nerve fibers which pass throughout the tumor can be seen arising from the ganglion cells. At this point the ganglion cells and nerve fibers are embedded in adipose tissue. Freeman's method $\times 150$.

it be undetermined it is of interest to know that intraspinal neoplasms can produce such a condition.

With the appearance of these phenomena obviously not explicable on the basis of an anterior poliomyelitis, the progression of the paralysis and the development of hyperactive reflexes, clonus, and positive Babinski's sign, it was evident that the previous diagnosis was incorrect.

The lumbar puncture which revealed the typical findings of a complete obstruction of the spinal subarachnoidal space confirmed this belief.

The roentgenograms (Figs. 1 and 2) of the lumbar spine were typical of an enormous expand-

ing intraspinal lesion. Similar pictures have been observed in other cases in the cervical as well as the lumbar region. One such case with a very large ependymoma filling the entire lumbar canal dilating it and eroding the pedicles and laminae has been recently reported from this clinic by Hamby.

Lipiodol was utilized in this case because with the absence of any sensory change the confusing nature of the motor alteration, both flaccid and spastic phenomena being present, it was impossible from the neurological examination accurately to determine the upper limit of the tumor. As is so often true with tumors in this region (Harkins) the illustrations show that the lipiodol successfully defined the upper limit of the neoplasm. In this clinic no irritation of more than very temporary duration and slight intensity has ever been observed from lipiodol introduced into the subarachnoidal space, and there would seem no reason for hesitation in its employment whenever it is indicated.

It has been apparent in many cases that severe compression of the spinal cord may be compatible with retention of normal or nearly normal sensation. This seems especially true in children and has been noted by Walker and Bucy in cases of subdural abscess of the spinal cord in which there was marked alteration in the motor functions of the spinal cord with but little effect upon sensation. Why this should be so is not apparent. It is true that in the present instance the paralysis was probably in a large measure the result of compression of the anterior horn cells rather than the pyramidal tract. However that is a situation



Fig. 11. Posterior columns of spinal cord removed with mural nodule. This area is composed of a large number of nerve fibers all running in the same area, parallel to the spinal cord. Many fibers are degenerated and close inspection will reveal swollen fibers and a few degenerative end-balls even at this low magnification. Freeman's method $\times 70$.

TABLE I—REPORTED CASES OF TERATOID TUMORS OF THE SPINAL CORD

Author	Sex, age in years	Location	Size	Ectodermal structures	Mesodermal structures	Structures hard to classify
1. Gowers, 1876	Adult	Conus medullaris	5 x 5 0.4 in		Connective tissue, striated muscle, fat	
Gerlach, 1891	M 36	Upper cervical	about 5 mm long		Connective tissue primitive and adult muscle fibers, cartilage	Embryonal tissue
2. Forbes, 1905	M 55	Midcervical	Size of hamot bone		Cellular connective tissue, embryonal and adult striated muscles, fat cells, multinucleated giant cells (osteoclasts?)	
4. Frick, 1911	F 4	Second to fifth lumbar vertebrae		Numerous blood hairs	Connective tissue, bone with myeloid tissue in marrow fat	
5. Andre-Thomas and Querry, 1913		Cervical and dorsal cord		Ependymal cells, glial elements (glioma)	Connective tissue, striated muscle, numerous blood vessels	
6. Belschowsky and Unger, 1920	M 37	Third cervical	Twice walnut size	Fine hairs	Connective tissue, fat cells, endothelioma or alveolar sarcoma	
7. Hammond, 1926	F 21 days	Sacral	6 cm diameter	Stratified squamous epithelium, nerve, glial cells, ependyma, ependymal glioma (?)	M, mucous connective tissue, smooth muscle, cartilage, fat, lymphoid cells	Cysts lined with high columnar cells
8. Kahle and Falton, 1928	M 2	6th dorsal to 1st lumbar	6 x 5 cm	Mucous and serous glands, large myelinated nerve fibers	Connective tissue, smooth muscle	Cysts lined with ciliated columnar cells
9. Kahle and Falton, 1928	F 17	3rd and 4th cervical		Mucous and serous glands, myelinated nerve fibers, ganglion cells (?)	Connective tissue, smooth muscle, fat, cartilage, lymphoid tissue	Cysts lined with ciliated cuboidal to columnar cells
10. Hosoi, 1930	M 24	2nd and 3rd lumbar	About 5 x 3.5 cm	Nerve fibers, pacinian corpuscles	Connective tissue, smooth muscle, fat cells	Glands lined with ciliated and nonciliated columnar cells
11. Bucy and Buchanan, 1934	M 34	11th dorsal to 4th lumbar		Ciliated stratified columnar epithelium, ciliated cuboidal epithelium, mucous glands, myelinated nerve fibers, ganglion cells	Connective and adipose tissues, blood vessels, cartilage, lymphoid tissue	

peculiar to the present case whereas the fact that the sensory pathways are more resistant to pressure than the motor is borne out by cases of tumors in all parts of the spinal cord. In fact this observation concerning the greater resistance of the sensory pathways is not limited to such agents as mechanical pressure but is also seen in other conditions. For instance in both multiple sclerosis and progressive muscular atrophy sensory changes are uncommon and of little moment whereas microscopic examination of the spinal cords from such cases often reveals marked demyelination which is not limited to the efferent or motor tracts but is disseminated throughout the spinal cord.

One is also often amazed at the amount of recovery which occurs after such a severe degree of spinal cord compression. This seems especially true of children and was observed in the cases of subdural abscess as well as in the present case, in all of which the compression was of long standing. Not only is the degree of recovery striking but its rapidity as well. In the present instance the patient after months of illness malnutrition and in-

capacity was able to stand 2 weeks after operation and to walk in 4 weeks.

LITERATURE

The reports dealing with intradural teratomata were thoroughly dealt with by Hosoi in 1931. There do not appear to have been any further additions to the literature since that time. It does not seem necessary to repeat Hosoi's review, rather I have appended his table (Table I) to which I have added the present case.

In 1932 Bucy and Hammond recorded an example of a teratoma arising outside of the spinal canal but connected with its neural contents by a narrow stalk. They found two similar cases those of Sonntag and Aloï in the literature. These extra spinal teratomata, all intimately connected with the nervous system, are in all probability closely related to those arising within the dura. They are very similar in gross and microscopical appearance.

SUMMARY

A case of bilateral teratomatous tumor arising from the posterior columns of the lower end of the

spinal cord is here recorded. The tumor lay within the arachnoid and was obviously of long standing for it had produced a marked dilatation and erosion of the spinal canal. The growth had severely compressed the spinal cord, this compression in turn giving rise to a mixed and alternating spastic and flaccid paraplegia with considerable subjective pain but without detectable sensory disturbance. A laminectomy was made and the entire cystic neoplasm was removed. This operation was rapidly followed by a striking recovery of all functions.

REFERENCES

1. BUCK, P. C. and HAYMOND, H. E. Lumbosacral teratoma associated with spina bifida occulta. *Am J Path.* 1932, 8: 339-346.
2. HANCOCK, W. B. Tumors in the spinal canal in childhood. *J. Nerv. & Ment. Dis.* 1935, 81: 34-42.
3. HARRISON, H. N. Use of iodized poppy seed oil in differential diagnosis between tumors of conus medullaris and of cauda equina. *Arch. Neurol. & Psychiat.*, 1934, 31: 453-503.
4. HOSOKI, K. Intradural teratoid tumors of the spinal cord. *Arch. Path.*, 1935, 11: 3: 5-83.
5. KURZE, L. S., and FULLER, J. F. A clinical and pathological study of two teratomatous cysts of the spinal cord, containing mucus and ciliated cells. *Surg. Gynec. & Obst.*, 1929, 4: 397-411.
6. OGGERTSON, A. W., HARVEY, S. C. and RICHARDS, H. G. Observations on sympathetic vasomotor pathways. *Ann. Surg.* 1932, 96: 744-753. Studies on the course of vasomotor fibers as measured by thermic changes in the feet after arterial ligation and section of the spinal cord at various levels. *J. Clin. Invest.*, 1932, 11: 1065-1074.
7. WALKER, A. E., and BUCK, P. C. Congenital dermal sinuses. *Brain*, 1934, 57: 401-42.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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SYMPATHETIC OPHTHALMIA

IN the group of inflammatory diseases of the uveal tract which come under the general classification of uveitis sympathetic ophthalmia stands out as a clinical entity. It follows penetrating injuries to the eye, operations on the eye involving the iris or ciliary body, and rarely non penetrating injuries such as contusion and intra-ocular growths. The incidence is comparatively rare yet the insidiousness of the disease and the great probability of total loss of vision when it occurs make it the most dreaded of complications in cases of injury to the eye. Early diagnosis, prophylaxis and treatment are of great importance from the standpoint of in dustrial compensation.

The onset of symptoms has been noted 2 days after the injury the average period however, has been from 2 weeks to 6 weeks, the longest period reported has been 48 years. The symptoms of sympathetic ophthalmia are not always easily recognizable in the early stages particularly in cases in which the onset is delayed or in which there is obscure or uncertain evidence of initial injury but by bio-

microscopic examination of the aqueous humor in the post lental space and about the inferior angle of the anterior chamber, the presence of cells may be detected before other signs of the disease appear. Low intra-ocular tension mild circumcorneal injection, cells appearing in the aqueous humor of a previously healthy eye a few days or weeks following a penetrating injury to the other eye, constitute sufficient grounds for presumptive diagnosis of sympathetic ophthalmia and warrant energetic therapeutic measures.

The answer to the question of what therapeutic measures are adequate to arrest the disease is not to be found in any textbook or treatise. As is usually the case when an adequate method of treatment is not known many methods are recommended. A basis for specific treatment depends on etiology. There are many theoretic and some demonstrable explanations for development of sympathetic ophthalmia, none of which is conclusive, but the most highly regarded theories at present are as follows: (a) infection from without by a bacterial agent that has or that acquires, affinity for uveal tissue by penetration into the injured eye whereupon it becomes particularly potent and affects the fellow eye by transmission through the blood or lymph or by migration along the optic nerves, (b) the presence of a filtrable virus somewhat similar in action to the virus of herpes, (c) allergy particularly to uveal pigment, and (d) endogenous tuberculosis. There are some reasons for believing that the etiological factors may be different in different cases but the histopathological picture is characteristic and does not support this assumption. It is ex-

tremely difficult to reproduce the disease experimentally. Although a great deal of information has been gained from laboratory studies of the disease, treatment must yet be based on clinical experience.

During the decade of the World War there was developed a great confidence in the efficacy of parenteral injection of foreign proteins as a prophylactic against and for treatment of ocular inflammation following injury. The value of antitetanic serum after injury was generally acknowledged, but it was regarded as a specific agent. The low incidence of sympathetic ophthalmia from injuries to the eyes of soldiers in the war has been attributed to the use of antitetanic serum and prophylactic vaccines. Fear of anaphylaxis restricted its applicability in some cases. There were, however, no dangerous complications following parenteral injection of sterilized milk or properly prepared typhoid vaccine. Diphtheria antitoxin was regarded as particularly dependable and safe for children, and as sympathetic ophthalmia occurs most often in children, the remedy became very popular.

When used as a prophylactic, foreign proteins are so effective in preventing the disease that sympathetic ophthalmia now is regarded as one of the most unlikely complications of surgery of the globe or following injury to the eye, even when the operation or the injury is in the so-called danger zone. By energetic treatment of the disease in the early stages by the same means, it often can be arrested and vision saved. This clinical experience points out two obvious and significant truths: (1) that effective therapeutic measures may be developed on the basis of clinical experience without regard to the results of laboratory investigation of etiological factors and without a full understanding of the ways in which healing is brought about; and (2) that clinical experience in the use of foreign protein for

prophylaxis and treatment of sympathetic ophthalmia has shown it to be so effective when properly given that it should be adopted as a routine procedure in every case of injury that makes the eye subject to the disease.

W. L. BENEDICT

PNEUMONECTOMY AND LOBECTOMY

UNTIL 4 years ago no patient had ever survived the removal of an entire lung, and until 6 years ago the danger of the complete removal of a pulmonary lobe was so great as to be prohibitive. The phenomenally rapid technical advances that have been made in the operations of pneumonectomy and lobectomy during the last few years furnish another illustration of the successful application of physiological principles to surgical problems.

During the last 4 years at least six total pneumonectomies have been successfully performed for bronchiectasis involving an entire lung, and at least twelve pneumonectomies for malignant disease. Although the present mortality rate of approximately 25 per cent will probably be considerably reduced by the application of the lessons already learned, pneumonectomy will always be a relatively dangerous operation. A simple wide exploratory thoracotomy undertaken to determine the operability of a carcinoma in an old person whose general resistance is poor is, however, apt to prove to be a more hazardous operation than the actual removal of a lung in a young or middle-aged person in good condition.

The fact that pneumonectomy has been demonstrated to be possible, and not particularly hazardous in patients in reasonably good condition, has already stimulated interest among internists and bronchoscopists in the diagnosis of bronchial carcinoma in the operable stage. As a direct result of this

growing interest in early diagnosis, it is almost certain that a steadily increasing number of successful pneumonectomies, followed by indefinitely prolonged freedom from recurrence of carcinoma, will be reported.

The surgical problems presented by carcinomatous and bronchiectatic patients are quite different. Bronchial carcinoma is frequently located so centrally that the stem bronchus must be divided in its intramediastinal portion after the separate ligation of the pulmonary artery and veins. The dissection within the mediastinum and the healing of the sutured bronchial stump are favored by the one stage operation that is usually possible in cases of carcinoma. A one stage operation is feasible because the absence of pronounced pulmonary suppuration in the operable phase of carcinoma reduces the danger of infection of the pleural cavity, and the absence of extensive pleural adhesions reduces the operating time. The pleural cavity may be tightly closed without tube drainage thus permitting the postoperative pleural exudate to become rapidly organized and pull the ribs, hemi diaphragm, mediastinum, and remaining lung toward the pleural cavity until it is obliterated. In this event a thoracoplasty is of course unnecessary.

All the successful pneumonectomies for carcinoma have been one stage operations and for bronchiectasis two stage. A one stage operation in a bronchiectatic patient would be unduly hazardous because virulent infection would probably attack the pleura that has not been protected by the traumatic inflammatory wall that a preliminary stage would have produced. Open drainage of the empyema, or the early opening of the infected hilar bronchus, after a one stage operation would expose the patient to grave danger of cardiorespiratory decompensation from pendulum respiratory movements of a mediasti-

num that was as yet mobile. Since the stem bronchus need not be divided within the mediastinum in bronchiectatic patients, the extramediastinal portion of the hilum or preferably the individual lobar hila may at the second stage be circumferentially ligated or sutured after their division. Because of the extensive pleural adhesions that are usually present in patients having bronchiectasis of an entire lung a posterior incision is best, whereas an anterior incision is preferable for carcinoma patients because it gives direct access for the dissection of the pulmonary artery and veins in the anterior part of the hilum and because pleural adhesions are usually only few in number.

The mortality rate from the newly developed lobectomy operations for unilateral bronchiectasis (in bilateral disease the rate is prohibitively high) has been reduced to less than 13 per cent in a total of 116 patients operated on in the four clinics in which the death rate is the lowest. Fifty nine of these patients were operated on by the two stage technique with a mortality rate of 10.2 per cent and the remaining 57 by the one stage technique with a mortality rate of 12.5 per cent. The published mortality rates in other clinics using the one stage operation are 11.1 per cent, 23 per cent, 25 per cent, and 29.6 per cent, respectively. In spite of the lower death rate of the two stage operation, there is at present a sharp division of opinion as to which operation is the better.

In the two stage lobectomy the undiseased lobe is adherent at the time that the second stage is performed, and the mediastinal, diaphragmatic, and costal pleura over the lobe that is to be removed contains a traumatic inflammatory barrier against the infection that will follow the removal of the lobe. These two factors protect the patient against the development of a virulent total empyema and

against the pendulum respiratory movements of the mediastinum and the paradoxical movements of the ipsilateral lobe that would probably occur if the hilar bronchus opened prematurely or if the thoracic wall incision could not be kept tightly closed during the first week or two after operation. The chief disadvantages of the two stage operation are that the patient must be operated on twice and that the empyema that occupies the space that contained the diseased lobe is larger and takes longer to become closed than does the empyema remaining after the one stage operation for the reason that the adhesion of the remaining lobe to the thoracic wall prevents its expanding rapidly to fill the empyema cavity. A further disadvantage of the two stage technique is that approximately half of the patients require a muscle graft operation to close a residual bronchial fistula.

The one stage operation is convenient for the patient and surgeon and by virtue of the rapid filling of the space from which the diseased lobe was removed the postoperative convalescence is relatively short the broncho-pleural fistula that develops usually closes

spontaneously. The chief disadvantages of the one stage operation are (1) the relatively long operating time required increases the danger of shock and postoperative pneumonia, (2) the tourniquet that is used to control the hilar vessels while the hilum is being closed by suture may slip with a resulting fatal hemorrhage (3) some of the many divided hilar vessels cannot be identified for certain closure by the hilar sutures, and may be the cause of a fatal postoperative hemorrhage (in the two stage operation the hilum is usually tightly ligated *en masse* and operative or postoperative hemorrhage is a rare complication) (4) severe infection of part or all of the pleural cavity sometimes occurs. In spite of certain obvious advantages of a one stage lobectomy the two stage procedure seems at the present time to be the safer and therefore, the preferable operation.

The progress that has already been made with the operations of pneumonectomy and lobectomy justifies the inclusion of pulmonary carcinoma and intractable cases of unilateral bronchiectasis among the curable diseases.

JOHN ALEXANDER

EARLY AMERICAN MEDICAL SCHOOLS

THE MEDICAL FACULTY OF LAVAL UNIVERSITY, QUEBEC

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THE Medical Faculty of Laval University has been teaching for some 80 years since it was organized in the fall of 1853. To understand its real origin, one must go back as far as the beginning of the French colony of Nouvelle France and follow up the evolution of French teaching which has been followed since the foundation of the school.

In 1663 the first Bishop in North America François de Montmorency Laval, established the Quebec Seminary. In 1676, a Royal Charter was received from the French King Louis the XIV. The Seminary created Laval University in 1852 and obtained then a Royal Charter from Queen Victoria of England together with the Papal Bullas as a Catholic university. From this moment Laval jealously preserved that classical education of the French and other great universities in Europe such as Oxford, Cambridge, Rome and Louvain. Laval has four faculties: divinity, law, medicine, and arts comprising sciences and letters. French is the teaching language, and technique books in the medical faculty are all in French.

These notions were necessary to have in full sight the situation of the Medical Faculty of Laval University.

Before its foundation the student who desired to enter medical practice in Quebec City had to study with a practitioner who could initiate the future physician to the first notions of medical science and the practice of medicine and surgery. Since 1847 a medical school had been organized which was called L'École de Médecine incorporée de la Cité de Québec. In this school medicine and surgery were taught and clinical lectures were given at the Miséricorde Hospital, while dissecting rooms were provided successively in different parts of the city. The professors of this school were called upon to become the first professors of the Medical Faculty of Laval. At the opening of the university in 1854 the faculty had 6 professors with Dr. Jean Blanchet as dean. It counts actually 20 professors, 5 are full time, 19 associate professors, 6 in charge of lectures and 27 assistants. Of this staff of 66, 51 have had postgraduate work in Paris, Strasbourg, Bordeaux, Lyons, for periods varying from 1 to 3 years; others have done postgraduate work in New York or other American cities.

To be admitted to the medical faculty the student must either be a bachelor of arts of Laval or any recognized university, or have passed the special

examination of admission to the study of medicine in the Province of Quebec established by the Medical Board of the Province, or submit the regulations of admission wanted in the Province or country to which he belongs. For American students, they must prove to have had 3 years of premedical work for entrance in the first year and have been studying in a medical faculty classified A for other years. The students numbered 263 in 1933-1934.

The course in medicine is a full 5 year medical course of 8 months. All lectures are given in French. Semestral examinations take place at the end of January and the beginning of May. Final examinations start on the fifteenth of May in every year. The presence of every student to lectures, practical work, and clinics is controlled every day. Lectures and practical work take place in the building of the medical faculty which was rebuilt in 1922. Clinics are given in the different hospitals connected with the faculty which include: The Hôtel Dieu de Québec, St. Sacrement Hospital, Laval Hospital, Maternity Hospital, Infant's Hospital (Crèche St. Vincent de Paul), Neuropsychiatric Clinic (Clinique Roy Rousseau) and Insane Asylum (Hôpital St. Michel Archange). Nominations in these hospitals are all controlled by Laval University; the total beds numbering over 4,000 of which 2,000 belong to the Insane Asylum.

Technical books on every subject are indicated to the students and must be bought at the university at the beginning of each year without the possibility of handing them over. The rest of the material, comprising microscopes and experimental apparatus, microscopic and macroscopic collections of specimens is furnished without charge in all departments.

A library of 5,000 books, with 145 periodicals, is at the disposal of the students at the medical faculty in addition to the possible use of the university library which contains over 150,000 volumes. The library is opened daily from 9:00 a.m. to 6:00 p.m. and from 8:00 to 10:00 in the evening. Special indexes are at the disposal of the workers.

Special lectures are given every year by noted medical men and students are admitted to all meetings of the medical societies at the school or in the hospitals.

MEDICAL SCHOOL

In 1922 owing to the activities of a group of professors and the elaborate direction given by the new

dean, Professor A. Roussseau, the school has been totally rebuilt and all departments organized to look after the practical training of an average of 50 to 60 students per year.

On the top floor stands the department of biology, histology and embryology under the direction of Professor Potvin, with large practical work laboratory for the first year students with a possibility of accommodation for over 80 students, private laboratory for the professors and helpers.

Next is the department of anatomy directed by Professor Garneau. The large dissecting room as well as the annexed lecture room can be attended by 100 workers. Complete collections of bones, normal anatomy specimens, charts and moldings are at the disposal of the students and large working shops are fitted to prepare all the material at the school. Private laboratory for the professor and for the prosectors with all necessary outfits completes the material organization for anatomy teaching.

The next floor is entirely occupied by the services of physiology and biological chemistry comprising laboratories for practical work in physiology at which students are trained by groups, large laboratory for biological chemistry laboratories and offices for the professors and work rooms to prepare the material together with a large lecture room. The stables of the school close to the building are under the direction of this department together with the department of biology and pathology. Physiology is under the direction of Professor Blanchet and biological chemistry actually in charge of Dr Marcoux.

The second floor of the school is occupied by the department of pathology and bacteriology. The Pathological Institute directed by Professor Vallée and Berger with the assistance of Dr E. Morin, associate professor examined and made report last year on 3,228 microscopic specimens. This department looks after the Cancer Center of Laval University which is directed by the same staff together with Professor Verina as surgeon. The department is fitted with a large laboratory for practical work and 5 private laboratories for the staff. The Museum of Pathology contains over 500 microscopic specimens of very first quality. A pathological

collection of over 12,000 microscopic specimens is at the disposal of students who receive free of charge a complete series of all lessons amounting to 115 slides. Fourteen papers were published by the staff during the last year and over 50 since the foundation of the Institute in 1928. Charts, microscopic drawings, and microscopic photographs are prepared in the department.

General lecture rooms, registrar's offices, reading room, and library occupy the main floor together with the dean's office and professors' meeting room. In the basement are the vestries, recreation room, experimental hospital for animals, book room of the library and the storing department for anatomy.

UNIVERSITY HOSPITALS

Students are obliged to follow hospitals during the third, fourth, and fifth year but are admitted even during the first 2 years. They follow the different services by rotation either as *stagiaires* or as *externes* for those who have had over 75 per cent on their marks on all subjects during the first and second year or as *internes* in the fifth year for those who after externship have obtained 75 per cent on all examinations during the third or fourth years.

Owing to the large number of beds provided by the different university hospitals as mentioned, students are distributed in very small groups in each of the medical, surgical wards or in special services and maternity. They have to look after a certain number of patients of which they are in charge, under control of the assistants and house surgeons and physicians, to report cases and besides attend the didactic clinical lectures which take place in every hospital. *Stagiaires* students rotate every 3 months, *externes* every 6 months, maintaining their service during the whole summer months as do the *internes*.

Diplomas are delivered after the fifth year to all who went through with success all written, oral, and clinical examinations, in medicine, surgery, midwifery, and pediatrics for the clinical part. No student can change from one year to another if he has failed on any subject.

The dean of the Faculty of the school is actually Professor P. C. Dagneau, and the secretary is Professor A. Vallée.

CORRESPONDENCE

MISSISSIPPI VALLEY MEDICAL SOCIETY

To the Editor A new medical organization to be known as the Mississippi Valley Medical Society was formally organized at Quincy Illinois, on April 8. The sole purpose of the new society is to hold an annual meeting each fall devoted to intensive post graduate instruction and conducted by the leading clinical teachers of the United States. The programs will be eminently practical and of particular interest to the general practitioner. The first meeting will be held in Quincy during the month of October or November and will be a 3 day session. The control of the organization is in the hands of a board of directors, consisting of one director to

each 1000 physicians in the states of Illinois, Missouri, and Iowa. Membership in the society will be open to all ethical physicians in their respective states. In order to get started quickly the board of directors has elected to place the membership fee and dues for the first year at only \$3.00 and life membership at \$25.00 provided these are paid before the time of the annual meeting. Charter membership will close July 1, 1935. Members will attend the annual meeting without payment of a registration fee.

Ethical physicians interested in the new organization are urged to communicate with Harold Swanberg, M.D., secretary treasurer, 211-224 W. C. U. Bldg. Quincy Illinois.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

PRATIQUE ANATOMO-CHIRURGICALE ILLUSTRÉE. By F. Paire, D. Giraud and S. Dupret. ARDREUX. FASCICULE II. RÉGION ABDOMINALE MOYENNE ET RECTUM. Paris G. Doin & Cie, 1935.

SURGICAL PATHOLOGY OF THE PERITONEUM. By Arthur E. Hertler. M.D. Philadelphia. Montreal and London J. B. Lippincott Co. 1935.

LA ROENTGENTÉRAPIE DES FIBROMYOMES DE L'UTÉRUS ET DES MÉTROPATHIES HÉMORRAGIQUES. By Paul Gibert. Paris. Masson et Cie, 1935.

SEGUNDO CONGRESO ARGENTINO DE OBSTETRICIA Y GINECOLOGIA, Buenos Aires 1934. By A. C. Christie. ECONOMIC PROBLEMS OF MEDICINE. By A. C. Christie. M.S. M.D. New York. The Macmillan Co. 1935.

THE PRINCIPLES AND PRACTICE OF UROLOGY. By Frank H. Netter. Philadelphia and London. W. B. Saunders Co. 1935.

LE FONCTIONNEMENT DE L'ESTOMAC APRÈS GASTRECTOMIE. By Charles Marx. Paris. Louis Arnette, 1935.

AIMS TO SURGERY. By Cecil A. Joll. M.S. (Lond.) M.D.

(Brit.) B.Sc. (Lond.) F.R.C.S. (Eng.) and Reginald C. B. Ledlie. M.B. B.S. (Lond.) F.R.C.S. (Eng.) 6th ed. Baltimore. Williams Wood & Co. 1935.

CLINICAL LABORATORY METHODS AND DIAGNOSIS. A TEXTBOOK ON LABORATORY PROCEDURES WITH THEIR INTERPRETATION. By R. B. H. Gradwohl. M.D. St. Louis. The C. V. Mosby Co. 1935.

PHYSIOLOGY IN MODERN MEDICINE. By J. J. R. Macleod. M.B. LL.D., D.Sc., F.R.C.P., F.R.S. Assisted in the present edition by Philip Bard, Edward P. Carter, J. M. D. Olmsted, J. M. Peterson, N. B. Taylor. 7th ed. St. Louis. The C. V. Mosby Co. 1935.

PHYSICAL DIAGNOSIS. By Warren P. Elmer. B.S. M.D. and W. D. Rose, M.D. 7th ed. St. Louis. The C. V. Mosby Co. 1935.

METHODS OF TREATMENT. By Logan Clendenen. M.D. 5th ed. St. Louis. The C. V. Mosby Co., 1935.

DISEASES OF THE SKIN. By Richard L. Sutton. M.D. Sc.D. LL.D. F.R.C.P. (Edin.) 9th ed. rev. and enl. St. Louis. The C. V. Mosby Co. 1935.

PRÄKTISCHE ANATOMIE EIN LEHR- UND HILFSBUCH DER ANATOMISCHEN GRUNDLAGEN ÄRZTLICHEN HANDELS. By Dr. T. von Lüne and Dr. W. Wachsmuth. Band I Teil 3. Arn. Berlin. Julius Springer 1935.

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Ethical physicians interested in this organization are urged to communicate with Dr. J. M. D. Olmsted, secretary, 1001 Broadway, Quincy, Illinois.

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SURGICAL PATHOLOGY OF THE PERITONEUM. By Arthur E. Hertler. M.D. Philadelphia: Montreal and London J. B. Lippincott Co. 1935.

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SEXUO CONGRESO ARGENTINO DE OBSTETRICIA Y GINECOLOGIA, Buenos Aires 1934.

ECONOMIC PROBLEMS OF MEDICINE. By A. C. Christie. M.S. M.D. New York: The Macmillan Co. 1935.

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AIDS TO SURGERY. By Cecil A. Joll. M.S. (Lond.) M.D.

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Ledlie M.B. B.S. (Lond.) F.R.C.S. —

more William Wood & Co. —

CLINICAL LABORATORY METHODS —

TEXTBOOK ON LABORATORY METHODS —

INTERPRETATION. By R. E. F. —

The C. V. Mosby Co., 1935.

PHYSIOLOGY IN MEDICINE —

Macleod M.B. LL.D., L.R.C.P. —

in the present edition by P. —

J. M. D. Olmsted, J. M. F. —

St. Louis: The C. V. Mosby Co. —

PHYSICAL DIAGNOSIS —

and W. D. Rose, M.D. —

Mosby Co. 1935.

METHODS OF TREATMENT —

5th ed. St. Louis: The C. V. Mosby Co. —

DISEASES OF THE SKIN —

Sc.D. LL.D., F.R.S. (Lond.) —

A.M. M.D., L.R.C.P. (Lond.) —

St. Louis: The C. V. Mosby Co. —

PRACTISCHE ANATOMIE —

ANATOMISCHEN GRUNDRISS —

Dr. T. von Lanz, Berlin —

ARM. Berlin Julius —

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

ROBERT B. GREENOUGH Boston, *President*

DONALD C. BALFOUR, Rochester *President-Elect*

HOWARD C. NATZIGER, *Chairman* THOMAS F. MULLEN *Secretary Committee on Arrangements*

THE 1935 CLINICAL CONGRESS IN SAN FRANCISCO AND OAKLAND

THE twenty fifth annual Clinical Congress of the American College of Surgeons will be held in San Francisco and Oakland, October 28-November 1, 1935. Under the leadership of a strong and representative committee, the surgeons of that great medical center on the Pacific coast have organized and are planning to provide a program of surgical clinics and demonstrations in their hospitals and medical schools that will present a complete showing of their clinical activities in all departments of surgery. The Committee on Arrangements has been assured of the hearty co-operation of the clinicians at the two medical schools and twenty seven hospitals that will participate in the clinical program.

A preliminary program of clinics and demonstrations as prepared by the Committee on Arrangements is published in the following pages. It will be noted that operative clinics and demonstrations in the hospitals are scheduled for the afternoon of Monday, October 28, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days. The schedules published at this time in tentative form will be revised and amplified as the work of the program committee progresses.

Among the special features of this year's clinical program will be (1) Cancer clinics demonstrating the treatment of cancer by surgery, radium and X-ray; (2) fracture clinics demonstrating modern methods of treatment; (3) clinics in traumatic surgery demonstrating the newer methods of rehabilitation of injured patients by surgery and physiotherapy.

In addition to the ophthalmological and otolaryngological clinics and demonstrations at the hospitals and medical schools, the committee in charge of the section on surgery of the eye, ear, nose and throat is preparing programs for scientific sessions on Tuesday, Wednesday, Thursday and Friday mornings at headquarters at which

distinguished specialists in these branches of surgery will present and discuss papers on subjects of clinical interest.

The following hospitals and medical schools will participate in the clinical program:

San Francisco—Children's, Franklin, French, Letterman General, Mary's Help, Mount Zion, St. Francis, St. Joseph's, St. Luke's, St. Mary's, San Francisco Shriners, Southern Pacific, Stanford University, United States Marine, University of California, Veterans Administration, Stanford University School of Medicine, University of California Medical School.

Alameda County—Alameda County Alameda Sanatorium, Alta Bates, Berkeley General, Children's, Cowell Memorial, East Oakland, Peralta, Providence, Samuel Merritt.

The Executive Committee of the Board of Regents is preparing programs for a series of five evening sessions. At the presidential meeting in the Opera House on Monday evening, the retiring president, Dr. Robert B. Greenough, of Boston, will deliver the annual address, and the new officers will be inaugurated. Dr. Donald C. Balfour, Rochester, president; Dr. Arthur W. Allen, Boston, and Dr. John A. Gunn, Winnipeg, vice-presidents. The American College of Surgeons oration will be delivered by Dr. George Crile of Cleveland. Sessions on Tuesday, Wednesday and Thursday evenings will be held in the Auditorium of the Veterans' Building when eminent surgeons of the United States and Canada, together with visiting surgeons from foreign countries, will present papers dealing with surgical subjects of timely importance. The annual convocation of the College will be held on Friday evening in the Opera House at which the 1935 class of initiates will be received into Fellowship in the College. The fellowship address will be delivered by Dr. Robert Gordon Sprout, president of the University of California.

Among the special features of the program for this year's Clinical Congress will be (1) A symposium on cancer, under the auspices of the College Committee on the Treatment of Malignant Diseases, on Thursday afternoon following the annual meeting at which further reports by clinicians from various parts of the country will present additional statistics on the cure of cancer. Other papers on the treatment of cancer descriptive of modern methods of treatment and the organization and administration of cancer clinics will be included. (2) A conference on fractures arranged in co-operation with the College Committee on the Treatment of Fractures on Tuesday afternoon. (3) A conference under the auspices of the Board on Industrial Medicine and Traumatic Surgery on Friday afternoon. All of these sessions will be held in the Gold Ballroom of the Fairmont Hotel.

HOSPITAL CONFERENCE

The annual hospital conference will open the Congress with a session in the Gold Ballroom of the Fairmont Hotel at 10 o'clock on Monday morning. An interesting program of papers, round table conferences and practical demonstrations dealing with problems related to hospital efficiency is being prepared for sessions to be held on Monday, Tuesday, Wednesday and Thursday in the Gold Ballroom of the Fairmont Hotel, and at several of the hospitals. A greatly increased interest on the part of surgeons in both the administrative and scientific phases of hospital work has been evidenced in recent years and the program for this year's conference will be unique in providing for discussions of subjects of interest to the three major hospital groups—medical, surgical and administrative. It is planned to make this year's program of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives, particular emphasis being directed toward professional standards and the vital problems related to medical economics.

HEADQUARTERS—TECHNICAL EXHIBITION

Headquarters for the Congress will be established at the Fairmont and Mark Hopkins hotels. At the former the Terrace Ballroom and Lounge, the Gold Ballroom and other large rooms on the main floor and on the terrace have been reserved for scientific sessions and conferences, registration and clinic ticket bureaus, bulletin boards, exhibits, executive offices, etc. The Peacock Court and Room of the Dons at the Mark Hopkins will be utilized for various scientific sessions.

The Technical Exhibition, including the registration and clinic ticket bureaus, will be located in the ballroom and lounge on the terrace floor of the Fairmont Hotel. In these rooms will also be found the bulletin boards on which the daily clinical program will be posted each afternoon. The leading manufacturers of surgical instruments, X-ray apparatus, operating room lights, hospital apparatus and supplies, ligatures, dressings, pharmaceuticals and publishers of medical books will be represented in this exhibition.

LOW RAILWAY FARES

Very low railway fares will be in effect for the Congress, the railroads of the United States and Canada having authorized an extension of selling dates and return limit for round trip summer tourist tickets to include the dates of the Clinical Congress with a return limit of November 30.

SAN FRANCISCO HOTELS AND THEIR RATES

In addition to the two headquarters hotels—the Fairmont and Mark Hopkins—there are a number of first-class hotels within short walking distance of headquarters providing ample hotel facilities at reasonable rates. The following hotels are recommended by the Committee.

	Minimum Rate with Bath	
	Single	Double
Bellevue, Geary and Taylor	\$3 00	\$4 00
Californian, Taylor and O'Farrell	3 00	4 50
Clift, Geary and Taylor	3 50	5 00
El Cortez, Geary near Taylor	3 00	4 50
Fairmont, Mason and California	3 50	5 00
Caylord, Jones near Geary	3 00	4 00
Mark Hopkins, Mason and California	3 50	5 00
Palace, Market and New Montgomery	3 50	5 00
Plaza, Post and Stockton	3 00	4 00
Sir Francis Drake, Powell and Sutter	3 50	5 00
Stewart, 353 Geary	3 50	4 00
St. Francis, Union Square	3 50	5 00

ADVANCE REGISTRATION

The hospitals and medical schools of San Francisco and Oakland afford accommodations for a large number of visiting surgeons, but to insure against overcrowding attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheatres, operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected therefore that those surgeons who wish to attend the Congress will register in advance.

Admittance to all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the

distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet

the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non transferable must be presented in order to secure clinic tickets and admission to the evening meetings.

COMMITTEE ON ARRANGEMENTS

EXECUTIVE COMMITTEE

HOWARD C. NAFFZIGER, Chairman THOMAS F. MULLEN, Secretary

LEROY C. ABBOTT
HAROLD BRUNK
EDMUND BUTLER
WHITFIELD CRANE

CHARLES A. DUKES
LEO ELOSSEYER
PHILIP K. GILMAN
OLIVER D. HAMLIN

FRANK HINMAN
EMILE F. HOLMAN
FRANK W. LYNCH
ALBERT R. KILGORE

JOSEPH L. MCCOOL
ISAAC W. THORAK

SUB-COMMITTEES—SAN FRANCISCO

Clinical Program Committee (General Surgery)—ALBION R. KILGORE, Chairman EDMUND BUTLER, THOMAS F. MULLEN

Clinical Program Committee (Eye, Ear, Nose and Throat Surgery)—JOSEPH L. MCCOOL, Chairman H. B. GRAHAM, WARREN D. HORN

Transportation Committee—EMILE F. HOLMAN, Chairman G. D. DELPRAT MILLARD R. OTTINGER

Public Meeting Committee—JACOB C. GORDON, Chairman HAROLD M. BERNHEIM, EDGAR L. GILCREEST

Golf Committee—LEROY BROOKER, Chairman HARRY ALDERSON JAMES MORGAN FRANK SHERIDY

HOSPITAL REPRESENTATIVES

SAN FRANCISCO—GENERAL SURGERY

Franklin Hospital—ERNEST GERRARD, LEROY BROOKER
French Hospital—ASA COLLIER, EDMUND MORRISSEY
Hospital for Children—LEROY ABBOTT ALMA PERKINSON

Letterman General Hospital—R. F. METCALFE
Mary's Help Hospital—ISAAC THORAK, RAYMOND MILLER, EVERETT CARLSON, DUDLEY SMITH

Mount Zion Hospital—HAROLD BRUNK FRANKLIN HARRIS, ALBERT L. BROWN

St. Francis Hospital—JAMES O'CONNOR, CALVIN A. WALLER

St. Joseph's Hospital—ALBION R. KILGORE, J. MINTON MORGAN

St. Luke's Hospital—G. D. DELPRAT OTTO PFLOEDER

St. Mary's Hospital—THOMAS E. BAILEY PHILIP ANNOT

DANIEL SOOY

San Francisco Hospital—Stanford University Service LEO ELOSSEYER, H. MATTHEWSON L. ROGERS University of California Service HAROLD BRUNK, C. LATIMER

CALLANDER, GEORGE K. RIGGERS

Shriners' Hospital for Crippled Children—SYLVAN HAAS

Southern Pacific General Hospital—WILLIAM WARDENBURG, FRANK R. GERRARD

Stanford University Hospitals—EMILE HOLMAN, PHILIP K. GILMAN, FREDERICK REICHMERT

Stanford University School of Medicine—LEROY CRANE, EDWARD RICHMOND

United States Marine Hospital—MARK J. WHITE, RICHARD L. WATSON

University of California Hospitals—HOWARD C. NAFFZIGER, H. GLENN BELL

University of California Medical School—LANGLEY PORTER, WALLACE TERRY

Veterans Administration Hospital—P. E. JORDONOV, BEN THIEL H. HENNING, JOHN A. KENNEDY

SAN FRANCISCO—SURGERY OF THE EYE, EAR, NOSE AND THROAT

French Hospital—EDWARD C. FABRE RAJOTTE, VICTOR D'ERCOLE

Hospital for Children—GEORGE HOFORD

Letterman General Hospital—A. E. SCHLACKER, H. C. MAXWELL

Mary's Help Hospital—FRANK HAYD, J. W. CRAWFORD

Mount Zion Hospital—FRANK ROGER, HERBERT CORRY

St. Francis Hospital—CONSTANTINE BRITCA, ALBERT RAWLINS

St. Joseph's Hospital—ROY PARKINGTON

St. Luke's Hospital—ANDREW E. EDGERTON CHARLES BATES

St. Mary's Hospital—FRANCIS CUNLAY, STANLEY BURKE

Southern Pacific General Hospital—WILBUR SWETT

Stanford University Hospitals—EDWARD SEWELL, HANS BARKAN, HARRINGTON GRAHAM, LOUIS MORRISON

United States Marine Hospital—RALPH ASHLEY

University of California Hospitals—WALLACE SMITH, FRED C. CORDELL, ROBERT C. MARTIN, C. ALLEN DICKET

Veterans Administration Hospital—J. J. CAVENESS, OTTO BARKAN

OAKLAND EXECUTIVE COMMITTEE

OLIVER D. HAMLIN, Chairman
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WHITFIELD CRANE, Secretary

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PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY, GYNECOLOGY OBSTETRICS ORTHOPEDICS, UROLOGY,
SURGICAL PATHOLOGY ETC

OPERATIVE CLINICS IN SAN FRANCISCO HOSPITALS—DAILY

SAN FRANCISCO HOSPITAL

University of California Service

- HAROLD BRUM, GEORGE K. RHODES, A R. KILGORE
C. L. CALLANDER, S. H. MERTZER, A. L. BROWN
H. W. STEPHENS, F. S. FOOTE, M. W. DENYHAM,
H. M. BLACKFIELD and L. GOLDMAN. General surgery
F. HOOKMAN, C. JOHNSON, S. OLSEN, L. PLAYER, J. J. SUL-
LIVAN, W. A. CARROLL and T. O. POWELL. Urological
operations
W. G. MOORE, A. M. VOLLMER and M. SCHULZE. Gynecolo-
gical operations
H. W. FLEMING, H. A. BROWN and L. B. LAWRENCE.
Neurosurgical operations
LEON ARBOTT, F. G. LINDE, F. C. BOST, W. J. COX and
K. O. HALDEMAN. Orthopedic operations

Stanford University Service

- LEO ELIASSER. Lobectomy for lung tumor. flap operation
for tuberculous empyema. disarticulation at knee joint
W. L. ROOTER. Apicectomy (paraffin fill)
J. M. MERTZER. Gastric resection (Billroth II)
EDMUND BUTLER. Pylorectomy for peptic ulcer. stricture
of colon, congenital
J. CLINE. Exploration of biliary duct
C. MATTHEWSON. Open reduction of spiral fracture of the
tibia. sequestrectomy for tuberculosis of the pelvis
D. KING. Nonunion of carpal scaphoid
M. R. OTTINGER. Resection for carcinoma of the colon
E. TOWNE. Laminectomy for decompression of cauda
equina
E. MORTIMER. Removal of cord tumor
L. REYNOLDS. Cystectomy for carcinoma of the bladder
G. HARTMAN. Suprapubic prostatectomy
L. MICHAELSON. Plastic on kidney pelvis
R. CRAIG. Nephrectomy
K. SCHAUFF. Removal of fibromyoma of the uterus
A. PETTIT. Vesicovaginal fistula
H. VON GILDERN. Perineal repair operation
C. COOLEY. Operation for pelvic inflammatory disease
R. DUNN. Hyam's coagulation of the cervix
D. DALLAS. Vaginal hysterectomy

UNIVERSITY OF CALIFORNIA HOSPITAL

- HOWARD C. NAFFZIGER, D. JONES, JR. H. BROWN and R.
ALLEN. Neurosurgical operations
HAROLD BRUM and H. STEPHENS. Thoracic surgery
R. ARBOTT, F. BOST, K. HALDEMAN and W. KETS. Ortho-
pedic surgery
A. MAXWELL, M. SCHULZE, D. MORTON and C. HAYDEN.
Gynecological and obstetrical operations
FRANK HEDMAN, C. JOHNSON, S. OLSEN and B. WAYMAN.
Urological operations
W. S. TERRY. General surgical operations. thyroidectomy
H. SEARLS and H. GLENN BELL. Carcinoma of colon
cholecystectomy. popliteal aneurism
C. ROWEN. Appendectomy. hernioplasty
M. S. WOOL. Carcinoma of rectum and lower bowel
F. FOOTE. Partial obstruction, new operations
L. O. BARTLETT. Carcinoma of breast.

STANFORD UNIVERSITY HOSPITAL

- EDMUND RIXFORD, EDMUND BUTLER, R. GILMAN, L. CRAN-
DER, EMILE HOLMAN and S. BURNELL. General ab-
dominal surgery, gastro-intestinal surgery. hernia
EMILE HOLMAN and LEO ELIASSER. Thoracic surgery
F. REICHERT and E. TOWNE. Neurosurgical operations
R. GILMAN, EDMUND RIXFORD, EMILE HOLMAN. Thyroid,
biliary tract, liver and pancreas surgery
A. L. FISHER, D. KING and M. MENSOR. Orthopedic
operations
J. DILLON and L. REYNOLDS. Urological operations
L. EMER, H. A. STEPHENSON, C. FLEHMANN, P. E. HOFF-
MAN, G. CRAIG and W. STEVEN. Gynecological and
obstetrical operations
F. REICHERT and EMILE HOLMAN. Cardiac conditions,
circulatory diseases
C. B. PALMER and R. BURROWS. Injections, anesthesia
R. A. SCARBOROUGH. Proctological operations
A. DAVIS and S. BURNELL. Plastic surgery. industrial
cases. skin diseases

MARY'S HELP HOSPITAL

- R. MILLER. Radical neck dissection.
E. CARLSON and C. C. McCRAE. Abdominal operations.
M. MENSOR and L. PARKER. Orthopedic surgery
M. VECIL. Urological operations
H. VON GILDERN and A. SCHMIDT. Gynecological and
obstetrical operations.

U S MARINE HOSPITAL

- ROBERT A. JOXIS. Excision of pilonidal sinus and rectal
operation. cholecystectomy and autoplasty (Gillies
tubular flap). Dupuytren's contracture
RICHIE L. WAUGH. Inguinal hernioplasty using pedicled
fascial strips. operation for sciatica (Heyman) at
thorotomy of the knee with excision of internal semi-
lunar cartilage. bunion operation (Peabody) phrenic
neurectomy
FLETCHER C. STEWART. Transurethral resection of pros-
tate

ST FRANCIS HOSPITAL

- G. B. O'CONNOR. Plastic surgery. Reconstruction of face
after burns. rib cartilage transplant to the nose. re-
moval of nasal hump. cleft palate reconstruction sur-
gery of the hand.
W. W. WASHINGTON. Thyroidectomy
L. R. REYNOLDS and O. NOLAN. Prostatectomy. ureteral
transplants.

ST LUKE'S HOSPITAL

- ALANSON WEEKS, G. D. DELFRAT, PAUL CASTELLUM, A.
H. ROSSBURG, OTTO H. PILZGUEY, DR. SULLIVAN,
DR. MOORE and ALBERT M. VOLLMER. General sur-
gical operations.
GEORGE J. MCCORMACK, RUDOLPH L. DRESEL and DR.
COX. Orthopedic operations.
L. P. PLAYER, HERBERT D. CRALL and MILEY B. WESSON.
Urological operations
J. M. MORGAN. Proctological operations

MOUNT ZION HOSPITAL

- HAROLD BRUNO Total thyroidectomy for cardiac disease
 F I HARRIS Tork operation for undescended testicle
 first and second stage procedures resection for lesions
 of descending colon radical mastectomy Percy
 cautery and endotherm
 A L BROWN Plastic repair of pendulous breasts herniot-
 omy
 W WALDEYER Appendectomy
 M GROFFER and A WHITE Blood transfusion, citrate,
 Linderman and Unger methods
 L HOFFMAN Hysterectomy
 L D PRITCH, A STREIB and DAVID CHARMAN Radical
 clavotomy fracture of os calcis
 H BLACKFIELD Plastic correction of congenitally pro-
 truding ear
 HAROLD BRUNO and A L BROWN Phrenic avulsion
 thoracoplasty
 A ZOMEL and D A SCHWAB Electrocoagulation of tu-
 mors of the rectum haemorrhoidectomy under local
 infiltration
 L C JACOBI Calculi of the urinary bladder transure-
 thral prostatectomy
 H A R KREUTZMANN The problems of urinary lithiasis
 nephrotomy pyelotomy nephrectomy
 B STRAUSS and M POLSKY Hydrocele operation plastic
 operation for phimosis cystoscopy
 A LESTER Injection of vas deferens for chronic epidy-
 mitis
 R K SMITH Classical omentum section
 A BERNSTEIN Demonstration of cervical repair imme-
 diately following delivery
 I PEARL Muscle splitting extraperitoneal lumbar sym-
 pathetic ganglionectomy a new approach muscle
 splitting posterior cervicodorsal sympathetic gan-
 gliothomy
 EDWARD H BOLTZ, HERBERT H SCHULTZ and DR LAZAR
 Demonstration of introduction of anesthesia by
 avertus vaginal gas and oxygen spinal

FRANKLIN HOSPITAL

- F GEHRLE Gastro-intestinal surgery
 L BROOKS Abdominal operations
 J SALE, V DILLON W MONTGOMERY and W COX In-
 dustrial surgery and orthopedics
 G W PIERCE and G O'CONNOR Reconstruction surgery
 of hand, face and neck after burns repair of eyelids,
 correction of lacerations contractures

ST JOSEPH'S HOSPITAL

- ALBION KILGORE, J M MCKENRY F SKEENE and C E
 SMITH General surgical operations
 R SOTO-HALL and K HALPERN Orthopedic operations
 F MCKENRY Neurosurgical operations
 H VON GILDERY Gynecological operations
 T GIBSON Urological operations

FRENCH HOSPITAL

- F A LOWE Fractured humerus internal derangements
 of knee joint
 G W PIERCE and G O'CONNOR Removal of nasal hump

ST MARY'S HOSPITAL

- T E BAILLY Gastric surgery gastrectomy
 ROBERT YOEHL Gall-bladder surgery cholecystectomy
 D SOOY Surgical intervention for duodenal ulcer
 C P MATHEZ Nephropathy for nephropathy
 E TOPHAM Inguinal hernia
 JOSEPH MCCARTHY Industrial emergency cases
 EDWARD BUTLER Surgery of the colon
 GEORGE K RHOADS Emergency surgery
 EDWARD MCKENRY Sympathectomy for Raynaud's dis-
 ease
 PHILIP ARKOT Obstetrical surgery
 T GIBSON Nephrectomy
 W FACLANDER Bronchoscopic diagnosis of lung abscess
 J LOVINGHAM Orr treatment for delayed bone union

LETTERMAN GENERAL HOSPITAL

- R F METCALFE Castration of cervix penoscrotal
 suspension of uterus gastrojejunostomy cholecys-
 tomy haemorrhoidectomy colostomy for rectal car-
 cinoma omentum section
 F L COLE Hernia appendectomy inguinal hernia,
 ventral hernia
 H S BLENNIS Genito-urinary operations electrical re-
 section
 B S BURNETT Thoracotomy for emphysema orthopedic
 operations bone graft, open reduction of tibia, re-
 vision of cartilage knee
 P E DODSON Caretting and insertion of Carter pessary
 for sterility

SOUTHERN PACIFIC HOSPITAL

- W B CONYER and J D HENNER Superior cervical
 sympathectomy for angina pectoris, moving picture
 demonstration in natural color
 C MATHEZ and T GIBSON Transurethral prostatectomy
 E GREENWOOD Cholecystectomy
 F R GIBARD Inguinal hernia ambulant treatment by
 injection
 C WALKER and J BOHM Open reduction of fracture
 OSCAR F NOGAN and THOMAS E. GIBSON Suprapubic
 prostatectomy
 W W WASHBURN Thyroid surgery

SHRIVERS' HOSPITAL

- SILVAN L HALL Longitudinal osteotomy transphas-
 tion of muscles in paralysis stabilization of foot
 fusion of spine, lengthening of leg congenital dis-
 location of hip Sever operation for obstetrical palsy
 ala with transplantation of teres major fusion of hip
 plastic operation

HOSPITAL FOR CHILDREN

- C HOAG Thyroidectomy
 MURIEL E EDWARDS Thyroglossal duct cyst
 ALMA PRYNGSTON Superficial hysterectomy total
 hysterectomy vaginal plastic

VETERAN'S ADMINISTRATION

- Staff Coffey operation for carcinoma of the rectosigmoid,
 second stage gastrectomy

CLINICAL DEMONSTRATIONS IN SAN FRANCISCO HOSPITALS—DAILY

GENERAL SURGERY

- A. S. WHITE and F. I. HARRIS. Injection treatment of hernia
- HAROLD BRUNN. Appendicitis.
- S. R. SHERMAN. Rupture of the spleen.
- J. HOMER WOOLSEY and H. GLENN BELL. Splenectomy
- WALTER B. CORRY. Inspection of an industrial medical and surgical center: ward rounds demonstration of cases postoperative treatment.
- EMORY RICHMOND. Knotty problems in industrial surgery
- Traumatic carcinoma of breast ruptured heart traumatic thrombosis of iliac and other large veins
- EMILE HOLMAN. Operative cure of recurrent and direct inguinal hernia.
- GEORGE K. RICHMOND. Hematogenous perinephric abscess peritonitis and drainage.
- M. W. DEBENHAM. Aseptic meningitis following spinal anesthesia
- A. L. BROWN. Pulmonary embolectomy motion picture demonstration of the Trendelenburg operation on cavalier
- H. BRODIE STEPHENS. Subphrenic abscess vaccination of the pleural and abdominal cavities
- WALTER BIRNBAUM. Tendon repair acute gonococcal tenosynovitis.
- ALSON R. KILGORE, OTTO H. PFLEUGER and R. S. STONE. Treatment of breast cancer and results.
- OTTO H. PFLEUGER. Soft tissue sarcomas
- ALSON R. KILGORE. Cystic disease of the breast cancer
- C. L. CALLANDER. Gas bacillus infection, new amputation of thigh in lower third treatment of septic joints
- EDMUND BUTLER. Emergency surgery
- EDMUND BUTLER, L. R. REYNOLDS, L. H. GARLAND and J. B. McNAUGHT. Old healed ruptured bladder. diagnostic difficulties and value of X-ray in diagnosis
- X-ray in differential diagnosis of acute abdomen
- EUGENE S. KILGORE. Circulatory disease in differential diagnosis of acute abdomen
- CARLETON MATTHEWSON JR. and J. B. McNAUGHT. Lymphogranuloma inguinale
- A. S. MORANTE. Postoperative infections
- I. W. THORNE. Squamous and basal cell carcinoma of face and neck, pathology diagnosis and treatment
- Z. E. BOLD. Biopsies and tumor surgery mixed tumors of the parotid.
- EVERETT CARLSON. Carotid body tumors splenectomy indications and technique.
- FRANK E. STILES. Treatment of varicose veins.
- J. F. RICKARD. Intestinal obstruction

SURGERY OF THE THYROID

- WILLIAM J. KEHR, HENRY H. SEARLS, JANE T. PAXSON and R. S. STONE. Activities of the thyroid committee of the University of California Hospital with follow up studies after various lines of treatment.
- HENRY H. SEARLS, E. I. BARTLETT and C. L. CONNOR. Chronic diffuse thyroiditis.
- HENRY H. SEARLS and JANE T. PAXSON. Clinical picture of toxic adenoma with normal or lowered metabolic rate.
- WILLIAM J. KEHR. The heart in parathyroidism
- M. L. MOVROSKY. Lingual thyroid
- THEODORE ALTHAUSEN. Surgical implications of hepatic damage in thyrotoxicosis
- R. J. MILLER. Parathyroid damage during thyroidectomy

GENITO-URINARY SURGERY

- FRANK HERMAN CLARK M. JOHNSON and BRENT VIETMAN. Tumors of the testicle, pathology demonstration of hormone tests, and results, uretero-intestinal anastomosis, experimental work, drawings and motion picture demonstration, demonstration of patients' prostatism pathology indications for different types of surgery end-results by different methods
- C. P. MATTHE. Surgery of the prostate
- T. E. GIBSON. Newer aspects of renal tuberculous
- L. P. PLAYER and H. D. CHALL. Grafts transplantation for urinary incontinence
- MILEY B. WESSON. Conservative surgical treatment of nephrolithiasis
- L. C. JACOBS. Calculi of urinary bladder suprapubic and transurethral prostatectomy
- H. A. R. KAUTZMAN. Urinary lithiasis, nephrotomy pyelotomy and nephrectomy
- BERNARD STRAUSS and M. I. POLSK. Operation for hydrocele plastic operation for phimosis
- A. EPSTEIN. Injection of vas deferens for chronic epididymitis
- J. V. LEONARD and GEORGE W. HARTMAN. Demonstration in urology
- C. P. MATTHE and T. E. GIBSON. Transurethral prostatectomy
- T. E. GIBSON and O. F. NOLAN. Suprapubic prostatectomy
- J. R. DILLON. Treatment of chronic pyelitis and pyelonephritis treatment of cancer of prostate technical improvements in surgical treatment of undescended testicle
- W. E. STEVENS. Unusual pathological conditions of the urinary tract in women.
- EDGAR POTH. A new aseptic technique for uretero-enterostomy mechanism of ascending infection of the urinary tract experimental observations
- SIMONY OLSEN. Tuberculosis of the genito-urinary tract urinary calculi
- CLARK M. JOHNSON. Trauma of the genito-urinary tract infections of the genito-urinary tract renal and para renal infections, renal anomalies
- L. P. PLAYER. Kidney lavage
- W. A. CARROLL. Ureteral lithiasis rupture of kidney
- T. O. POWELL. Newer knowledge of tumors of the testicle with special reference to gonadotropic hormone excreted in the urine.
- M. R. OTTMER, LLOYD R. REYNOLDS and J. B. McNAUGHT. Torek operation for undescended testicle torsion of testicle.
- GEORGE W. HARTMAN. Hematuria and pyuria renal tuberculosis
- W. A. SUMNER. Relationship of chronic infections to lesions of the genito-urinary tract.
- LEWIS MICHELSON. Obstruction of the neck of the bladder in the female
- R. GLENN CRAIG. Ureteral pain of obscure origin.
- MORRELL VECIL. Renal movability

SURGERY OF INFECTIONS

- A. S. WHITE. Treatment of staphylococcus infections with staphloids.
- S. A. GOLDMAN. Studies on staphylococcus infections.
- F. J. MCCARTHY. End results in infections of the hand.
- B. F. ALDEN. Relation of focal infection to Wassermann fast lues.

ORTHOPEDIC SURGERY

- GEORGE J. MCCORMACK, W. COX and R. L. DREHSEL. Fracture of neck of femur: treatment without external splinting.
- L. D. PROCTOR, A. B. STEIN and D. D. CHARNACK. Fractures of os calcis: replacement of tibial shaft by fibula following osteomyelitis, treatment of burnitis.
- R. L. WADSWORTH. Clinical demonstration of Roger Anderson "Ought-O-Matic" splint and skeletal traction and countertraction methods applicable to Thomas or Hodgen splints.
- LEROY C. ARBUTT. The shoulder joint.
- JOHN B. DE C. M. SAUNDERS. The shoulder joint.
- J. F. RIVINGTON. Vitamin C deficiency in arthritis.
- KENNY HALDEMAN and JOHN B. DE C. M. SAUNDERS. Demonstrations of bone growth.
- FRANCIS BAILEY. Heat therapy.
- F. A. LOWE. Internal derangements of knee joint, clinic and motion picture demonstration: fracture of hip, mercuric, clinic and motion picture demonstration.
- J. J. LOUVERGNE. Arthrodesis of foot.
- S. L. HARRIS. Application of Hibbs-Risser plaster for scoliosis: results of treatment for scoliosis: results of tendon transplantation. Legg-Perthes disease.
- J. J. SALLI, W. O. MONTGOMERY, V. M. DILLON and W. J. COX. Industrial surgery and orthopedics.
- J. H. O'CONNOR. Reduction of complicated fractures, closed methods, demonstration of cases, indications for open reduction.
- C. A. WALLACE. End results of open reduction of fractures: treatment of compression fractures of spine: 250 cases: fractures of clavicle and patella.
- W. W. WASSERMAN. Disabilities following fractures, factors influencing period of recovery.
- LEONARD W. ELY. Arthritis of the hip.
- D. KING. Functional anatomy and pathology of the shoulder joint.
- A. L. FISHER. Treatment of flat feet.
- MERRILL C. MERRICK. Osteogenic sarcoma of spine: relation of bacteriophage to the Orr treatment of osteomyelitis.
- NELSON J. HOWARD. Traumatic lesions of bursae, tendons and muscles.
- LEON PARKEE. Familial tendencies in Paget's disease.
- D. KING. Treatment of chronic sclerosing osteomyelitis.
- F. G. LINDSEY. Compression fractures of spine: non-union of fractures.
- F. C. BOETT. Hibbs-Risser treatment of scoliosis, dislocation of carpal scaphoid: fracture of ankle, ligamentous tears of ankle: treatment of fracture of os calcis.
- W. J. COX. Internal derangement of knee joint, rupture of ligaments, treatment of fracture of femoral neck with Smith-Petersen nails.
- KENNY O. HALDEMAN. Pathology of acute osteomyelitis: pathology of chronic infections of bone.
- RALPH SOTO-HALL and KENNY O. HALDEMAN. Fracture dislocation of cervical spine: Duncan's traction apparatus.
- PAUL E. JOHNSON, B. H. HENKINS and JOHN A. KENNELLY. Disability ratings of Veterans Administration for orthopedic conditions of the extremities.
- CARLETON ALLENBACH, JR. and J. B. McNAUGHT. Treatment of spiral fractures of tibia: open and closed methods of treatment of fractures of extremities, tuberculosis of pelvis.
- D. KING, J. M. MERRICK and R. A. SCARBOROUGH. Fracture of carpal scaphoid: surgical approaches to bones and joints, Orr method of treatment of osteomyelitis.
- NELSON J. HOWARD. Fractures of the upper end of the humerus, motion picture demonstration.

- MERRILL C. MERRICK and LEON PARKEE. Unusual fractures of the spine: treatment of osteomyelitis with surgical maggots.
- C. C. MCRAE. Injuries of small bones of the hand.
- EDGAR L. GILCHRIST. Problems in treatment of fractures.

THORACIC SURGERY

- HAROLD BRUNN, A. L. BROWN, H. ROSENBLUTH and J. J. SAMMON. Symposium on surgery of the heart with particular reference to adhesive pericarditis.
- LEO ELLINGER, PHILIP H. PITCHER, W. L. ROGERS, W. G. BUTLAND, DAVID A. WOOD, W. R. CLARK and L. H. GARLAND. Various types of bronchial stenosis: mycotic infections of the lung: tumors of the lung: emphysema.
- EMILE HOLMAY. Technical improvements in partial resection thoracoplasty: resection of transverse process, resection of scapula: ligation of the pulmonary artery as a therapeutic measure in pulmonary hemorrhage: carcinoma of lung simulating inflammatory disease.
- HAROLD BRUNN, SIDNEY J. SHIPMAN, H. BROOKS STEINHAUS, A. L. BROWN, M. W. DICKMAN and A. GOLDMAN. Lung resections, emphysema: artificial pneumothorax: parenchymal avulsion, thoracoplasty.
- ALABORN WICKES and G. D. DILLON. Thoracoplasty.
- RAY KESTLER. Diaphragmatic hernia.
- SIDNEY J. SHIPMAN. Pneumothorax in poikilotherms.
- W. B. FAULKNER, JR. Bronchiectasis: treatment of chest injuries.
- A. L. BROWN. Collapse therapy in pulmonary tuberculosis.
- S. STEINMAN. Lymphoblastoma of mediastinum.
- C. A. WALLACE. Phrenectomy for pleuropneumonia adhesions.
- A. GOLDMAN. Staphylococcal infections of the lung, chemotherapy in tuberculosis.
- T. F. MULLER. Antithoracic emphysema.
- MARY E. MATTHEWS. Experimental study of the effect of various pathological conditions upon the dual blood supply of the lungs.
- EDGAR POTTS. A simple apparatus for tidal and apical irrigation and its application in treatment of emphysema.
- DAVID A. WOOD and MARY E. MATTHEWS. Exhibit of clinical and experimental observations on the dual blood supply of the lungs in various pathological states.

NEUROSURGERY

- HOWARD C. NAFFZGER. Late results in the treatment of malignant ependymomas, brain tumors: factors influencing recovery after peripheral nerve injury: cervical ribs and "the scalenus syndrome without cervical ribs."
- HOWARD W. FLEMING. Subdural hematomas: cerebri-spinal rhinorrhea, relief of intractable pain, cranial approach for orbital tumors, craniocerebral myxomas.
- EDMUND MORRISSEY. Neurologic clinic on lesions of the cauda equina, diagnosis and treatment of subdural hemorrhage: diagnosis of subdural hemorrhage.
- O. W. JONES, JR. Spinal cord tumors.
- H. A. BROWN. Low back injuries, spinal cord injuries.
- E. B. TOWNE. Treatment of acute head injuries.
- F. L. RICHKERT. Neuralgias of cranial nerves, demonstration of patient and lantern slides.
- ROBERT AIRD. Electroencephalography: clinical and experimental: intradural alcohol injections for intractable pain.
- E. B. TOWNE, F. MORRISSEY, J. W. WOLFE and D. WOOD. Surgical lesions of the spinal cord: dynamics of epilepsy.
- L. B. LAWRENCE. Spinal cord tumors, tumors of cauda equina.
- LIX HARRIS. Regeneration of peripheral nerves of hand.

GYNECOLOGY AND OBSTETRICS

- WILLIAM G. MOORE. Endometrioids fibromyomata of uterus.
- A. M. VOLLMER. Rubin's insufflation test trichomonas vaginalis.
- R. K. SMITH. Classical cesarean section, motion picture demonstration.
- FRANK LYNCH, ALICE MAXWELL and R. S. STONE. Uterine cancer follow-up X ray therapy radium therapy.
- MARGARET SCHULZE. Special ovarian tumors.
- A. H. HEALD and ALICE MAXWELL. X ray pelvimetry direct method.
- PHILIP H. ARNOT. Conduct of labor in posterior position.
- LUDWIG EMGE. Dysmenorrhea, causes and treatment sterility diagnosis and treatment.
- C. F. FLEHMANN, P. E. HOFFMAN and GERTRUDE F. JONES. Endocrinological aspects of gynecology modern methods of diagnosis blood and urine hormone tests, biopsy of endometrium, hormone therapy.
- A. V. PETTIT. Results of hyperpyrexia in treatment of acute and chronic pelvic inflammatory disease.
- LUDWIG EMGE. Radiation therapy of carcinoma of cervix methods and end-results.
- A. M. VOLLMER. Treatment of abortions.
- MARGARET SCHULZE. Multiple pregnancies, pyelitis with pregnancy hydatidiform mole and chorio-epithelioma cardiac disease with pregnancy.
- KARL L. SCHAUFF. Fibromyoma of the uterus.
- HANS VON GELDERN. Plastic operations on pelvis.
- C. L. COOLEY. Demonstration of gynecological cases.
- R. D. DUDON. Treatment of incomplete abortions.
- D. A. DALLAS. Operations in obstetrics.
- BEVERLY SIMPSON. Separated placenta.
- ADOLPH E. SCHMIDT. Uterine bleeding.

SURGERY OF THE GASTRO-INTESTINAL TRACT

- HAROLD BRUNN. Cancer of the rectum.
- F. I. HARRIS. Cecalizing (chronic) enteritis (regional ileitis) treatment of appendix stump, noninversion.
- FRED H. KRUE. The more common complications of peptic ulcer.
- E. J. BEST, F. H. KRUE, THEODORE ALTHAUSEN and RALPH RADNOWITZ. Postoperative care of intestinal conditions.
- M. F. CUNHA. Primary duodenitis end-results of ulcer cases, types of operation, causes of recurrence.
- LEON GOLDMAN and THEODORE ALTHAUSEN. Pseudo perforation of peptic ulcer.
- J. HOMER WOOLSEY and H. GLENN BELL. Carcinoma of stomach.
- M. L. MONTGOMERY and JOSEPH M. SWINDT. Acute intestinal obstruction experimental and clinical.
- H. GLENN BELL. Subacute intestinal obstruction, localized type (chronic cecalizing enteritis).
- H. GLENN BELL and LEON GOLDMAN. Congenital lesions, tumors, diverticula of small bowel.
- M. S. WOOLY, LEON GOLDMAN and H. GLENN BELL. Carcinoma of large bowel.
- DUDLEY SMITH and J. W. MORGAN. Carcinoma of rectum.
- ASA W. COLLINS. Pylorectomy and gastro-enterostomy.
- LEROY BROOKS. Diagnosis and treatment of intestinal obstruction.
- ERNEST GREENFIELD. Radical surgery for gastric and duodenal ulcers diverticulitis of colon closure of colostomy preservation of anal sphincter.
- P. K. BROWN. Peptic ulcer indications for surgical treatment.

- W. W. WARBURN. Acute perforation of peptic ulcer complications and end results in 100 cases.
- J. A. GUILFOIL. Chronic appendicitis, end results of operation.
- J. E. BOHM. Mortality rate of operations for appendicitis.
- R. A. SCARBOROUGH. Developments in surgical treatment of carcinoma of rectum, 200 cases.
- EMILE HOLMAN. Causes for failure to control symptoms and to prevent gastrojejunal ulcer in gastric surgery.
- GUNTHER W. NAGEL, F. L. REICHERT and MARY E. MATTHEW. Chronic regional enteritis, clinical experimental.
- DAVID A. WOOD. Multiple primary carcinomata of colon complicating multiple polyposis of colon.
- NELSON J. HOWARD. Amebic granuloma of large bowel.
- HAROLD BRUNN. Carcinoma of large bowel carcinoma of rectum bowel obstruction.
- GEORGE K. RHODES. Spontaneous perforation of cecum from obstruction in distal colon.
- DANIEL SOOT. Choice of operation in gastric surgery.
- EDWARD TORHAM. End-results in surgery for gastric ulcer.
- H. P. HILL, GEORGE BARNETT, J. M. MEHRKE, J. W. CLINE, JR., CARLETON MATHEWSON JR., J. B. MC NAUGHT and A. C. MCKENNEY. Lesions of the upper gastro-intestinal tract amebic infections of liver and gastro intestinal tract.
- DUDLEY SMITH. Operation for rectal fistula and hemorrhoidectomy motion picture demonstration.

SURGERY OF THE BILIARY TRACT LIVER AND PANCREAS

- ALANSON WEEKS and G. D. DELPRAT. Common duct stone hydatid disease of liver: granuloma inguinale.
- F. I. HARRIS. Acute cholecystitis.
- CARL HOAG. Reconstruction of common duct.
- H. CLARF SHEPARDSON and HANS LISSER. Pancreatic dysfunction hypoglycemia.
- H. GLENN BELL and THEODORE ALTHAUSEN. Operative mortality and pre-operative management of cholecystitis, glucose therapy. Rose-Bengal and other tests.
- FRED H. KRUE and THEODORE ALTHAUSEN. Medical and surgical jaundice cirrhosis of liver differential diagnosis from carcinoma of stomach.
- JESSE L. CARR and FREDERICK S. FOOTE. Experimental work in human jaundice.
- KARL SCHMIDT. The bile salts.
- EMILE HOLMAN. Postoperative and inflammatory stenosis of the bile passages.
- M. W. DEBENHAM and J. M. SWINDT. Liver abscess.
- STANLEY H. MENTZER. Acute cholecystitis obstructive cholecystitis.
- ROSELYN A. YOELL. Gall-bladder anomalies.
- T. F. MULLEN. Recurrence of symptoms after biliary tract surgery.

ENDOCRINOLOGY

- R. F. ESCAMILLA. Abdominal pain of endocrine origin.
- SAMUEL COHEN and F. I. HARRIS. Treatment of undescended testicle by operation and glandular extracts.
- LEO STANLEY. Endocrinology in a penal institution.

CIRCULATORY DISEASE

- M. L. MONTGOMERY. Therapeutic venous occlusion.
- C. A. NOBLE, JR. Postoperative cardiac versus circulatory collapse.

CLINICS IN ALAMEDA COUNTY HOSPITALS—WEDNESDAY

ALAMEDA COUNTY HOSPITAL

- WHITFIELD CRANE and W. EARL MITCHELL—9 Carcinoma of stomach
 FRANK H. BOWLES and THEODORE LAWSON—10 Carcinoma of cecum
 H. W. HARRING and DON D. WEAVER—11 Carcinoma of colon
 LEMUEL P. ADAMS—12 Carcinoma of breast
 SCHMIDT EVEREDORHAM—9 Extrapleural thoracoplasty intrapleural pneumolysis clinic on phrenic interruption and thoracoplasty Discussion by CHESTER BURN
 WARREN B. ALLEY—12 Neurosurgery
 W. F. HOLCOMB—9 Arthroplasty of hip
 L. B. BAIRD—10 Arthroplasty of shoulder
 E. N. EWING—9 Total hysterectomy subtotal hysterectomy discussion of obstetrical service at Alameda County Hospital
 CLARENCE A. DUFFY—1 Gynecological cancer clinic Demonstration of intrapleural alcohol injection and presentation of cases
 ALBERT M. MEANS, LLOYD KENDALL, JOHN A. DAUGHERTY, T. I. BUCKLEY and associates—9 Perineal prostatectomy suprapubic prostatectomy resectoscopic prostatectomy Operations, demonstration of cases and discussion

Dry Clinics 2-4 30

- CHARLES A. DUKES and associates Cancer clinic
 HAROLD H. HITCHCOCK, N. A. CARY and associates Traumatic and orthopedic clinic demonstration of Sweetland cast dryer Bell table, plaster models, splints, etc.
 W. H. SARGENT and C. B. BOWEN X-ray exhibit and discussion
 GEORGE MOORE Pathological exhibit and conference

BERKELEY GENERAL HOSPITAL

Dry Clinics, 9-12

- FRANK D. WALKER Cholecystitis, observations and comments on surgical treatment
 CLAUDE H. CHURCH Ectopic pregnancy recurring on same side
 WILLIAM W. CHASE Polycystic kidney nephrolithiasis prosthetic management
 J. F. CARRISON Osteochondromatosis involving all epiphyses in one extremity clavicle drawings
 W. W. RUSCH Parathyroid disease, gross specimens and microprojections
 R. G. VAN NUY X-ray demonstration and discussion

CHILDREN'S HOSPITAL

- ROY NELSON—9 Demonstration of methods of treatment of esophageal strictures due to lye
 W. W. CHASE—9 Postmortem findings in the kidneys of children, lantern slide demonstration
 CLIFFORD SWIFT—9 Clinic on undescended testes Demonstration of postoperative results, discussion of the effect of antistasis X-ray demonstration of operation

ALTA RATES HOSPITAL

- Staff—9 Operations and dry clinics

SAMUEL MERRITT HOSPITAL

- WARREN B. ALLEY—9 Reconstruction of skull defects, operation and demonstration of cases
 W. F. HOLCOMB and D. D. TOWLE—9 Orthopedic operations and demonstrations
 MARK L. EMMERT—9 Rectal surgery and presentation of cases
 FRANK H. BOWLES—9 Thyroidectomy
 W. H. SARGENT—9 X-ray demonstration and discussion of cases
 ROBERT A. GLENN—9 Pathological exhibit demonstration of frozen section techniques and specimens
 WHITFIELD CRANE—9 30 Peptic ulcer Judd pyloroplasty
 W. EARL MITCHELL—10 30 Pelvic tumor
 HENRY KOPF—10 30 Cholecystectomy
 CHARLES A. DUKES—11 Apschysis, operation, demonstration of thoracic cases Discussion by HAROLD TRIMBLE

Dry Clinic, 2-5 30

- H. N. ROWELL, A. M. SMITH, W. H. STREETMAN, A. A. ALEXANDER, W. S. KUBER, STEWART V. IRWIN, H. GORDON MACLEAN, FLETCHER B. TAYLOR, VELDY G. ALDERSON, and HOWARD ROBERTS Symposium on pre- and postoperative care Management of surgical jaundice and stomach cases diabetes in surgery, traumatic and postoperative pneumonia, cardiac and renal complications, postoperative psychosis; allergy in relation to abdominal surgery discussion and demonstration of cases

PERALTA HOSPITAL

- J. L. LORR—9 Cholecystectomy
 ERIC A. MAYNOR—9 Carcinoma of breast, radical removal
 F. M. LORR and JOHN W. SARRICK—9 Porto caval anastomosis
 CHARLES B. FOWLER—9 Orthopedic treatment of spondylolisthesis correction of upper extremity involvement in polyomyelitis
 H. J. TRIMBLE and J. LUXFORD—10 Electric desiccation in cutaneous malignancies
 JOHN W. SARRICK—9 Vaginal plastic
 T. FLOYD BELL—10 Pelvic tumor
 T. C. LAWSON—11 Hernia, fascial repair
 P. N. JACOBSON—11 Bladder surgery
 PAUL MITCHELL—9 to 1 Pathological demonstration and exhibit
 J. D. COATES—9 to 1 X-ray demonstration and exhibit

COWELL MEMORIAL HOSPITAL

- HENRIET EVANS, ROBERT LEOX, C. A. KOPF and associates—9 Exhibit and discussion of latest advances in endocrinology, inspection of laboratories and hospital with special reference to the systematic method of care of university students, discussion of laboratory technique with particular reference to anesthetics

ALAMEDA SANATORIUM

- J. OGDON—9 Hernioplasty under local anesthesia, appendectomy
 G. R. BURKE—9 Cholecystectomy
 CLARENCE HALL—10 Resection of stomach

FRIDAY EVENING

3:30 Evening Medical Sessions
 1. **Ear, Nose and Throat**—Vocal Hygiene and its importance.
 2. **Ear, Nose and Throat**—The value of the larynx.
 3. **Ear, Nose and Throat**—The value of the larynx.
 4. **Ear, Nose and Throat**—The value of the larynx.
 5. **Ear, Nose and Throat**—The value of the larynx.
 6. **Ear, Nose and Throat**—The value of the larynx.
 7. **Ear, Nose and Throat**—The value of the larynx.
 8. **Ear, Nose and Throat**—The value of the larynx.

EAST OAKLAND HOSPITAL

7:30 Dinner—Bar & Deck
 8:00 **Ear, Nose and Throat**—The value of the larynx.
 8:30 **Ear, Nose and Throat**—The value of the larynx.
 9:00 **Ear, Nose and Throat**—The value of the larynx.
 9:30 **Ear, Nose and Throat**—The value of the larynx.
 10:00 **Ear, Nose and Throat**—The value of the larynx.
 10:30 **Ear, Nose and Throat**—The value of the larynx.
 11:00 **Ear, Nose and Throat**—The value of the larynx.

SURGERY OF THE EYE, EAR, NOSE AND THROAT

CLINIC IN SAN FRANCISCO HOSPITALS—DAILY

UNIVERSITY OF CALIFORNIA HOSPITAL

Friday
 JOSEPH L. MCCOOL, FREDERICK C. CORDIS, JOSEPH W. CRAWFORD, C. ALLEN DICKIE and DAVID O. HARRINGTON—9. Ophthalmological operations.
 R. C. MARTIN and FREDERICK C. CORDIS—9. Tonsillectomy.
 WALLACE SMITH, LOUIS MORRISON and EDITH STOKER—9. Otolaryngological operations.

Dry Clinics—

FREDERICK C. CORDIS. Surgery of the internal canaliculi.
 J. W. CRAWFORD. Tuberculosis of the eye.
 C. ALLEN DICKIE. Surgery of the vertical muscles.
 DAVID HARRINGTON. Contact glasses, practical demonstration.
 R. C. MARTIN and STANLEY BURKE. Injuries and repair of the facial nerve.

Thursday

JOSEPH L. MCCOOL, FREDERICK C. CORDIS, JOSEPH W. CRAWFORD, C. ALLEN DICKIE and DAVID O. HARRINGTON—9. Ophthalmological operations.
 R. C. MARTIN and FREDERICK C. CORDIS—9. Tonsillectomy.
 WALLACE SMITH, LOUIS MORRISON and EDITH STOKER—9. Otolaryngological operations.

Dry Clinics—2

JOHN SAUNDERS. Regional anatomy of the mastoid and pathways of infection of the intracranium.
 HOWARD C. NAFZIGER. Brain abscess arising from middle ear and mastoid infections.
 WALLACE SMITH. Phlebitis and thrombosis following middle ear and mastoid infections.

Friday—2

FREDERICK C. CORDIS. Surgery of complicated cataracts.
 J. W. CRAWFORD. The eye in diabetes.
 C. ALLEN DICKIE. The value of orthoptic treatment.
 DAVID HARRINGTON. Tobacco amblyopia and its treatment.

ST MARY'S HOSPITAL

Thursday—2

FRANK COSLAN, STANLEY BURKE and FRANK HOWE. Treatment of posterior sinusitis. Blood dyscrasias in relation to the ear, nose and throat. Treatment of bilateral abductor paralysis.
 FRANK HOWE. Radical antrum.

SAN FRANCISCO HOSPITAL

Thursday

WARREN D. HUNTER. External indirect eye history, uses, advantages and advantages.
 C. ALLEN DICKIE and J. W. CRAWFORD. Safety procedures in contact operations: albinism, intra-ocular hemorrhage, 51 sutures, preoperative medication.
 WARREN D. HUNTER, C. ALLEN DICKIE and J. W. CRAWFORD. The use of methylene blue in the treatment of ocular diseases.
 ARTHUR RAWLINSON. Osteoma of the antrum: some curious foreign bodies in the lungs: cases of recovery from otitis meningitis: extensive osteomyelitis of the frontal bone.
 HARRINGTON B. CRAWFORD. Foreign bodies in the lungs, stenosis of the esophagus: cancer of the larynx.
 HARRINGTON B. CRAWFORD and J. M. WILSON. Extensive abscess of the meninges.
 RAY ASHLEY. Treatment of tuberculosis of the larynx.

HOSPITAL FOR CHILDREN

Thursday

GEORGE N. HOSKIN and AVERY M. HICKS. Technique for the determination of the hydrogen ion concentration of tears. The significance of pH of tears in ocular symptoms and treatment. Indications for and results of orthoptic training. Relation of vertical imbalance of extra-ocular muscles to gastric symptoms, posture, temperament and aptitude for school work and occupation. Congenital muscle palsies. Motion picture demonstration of O'Connor technique for heterophoria and heterotropia.

Days to be announced

GEORGE N. HOSKIN and AVERY M. HICKS—9. Extraction of congenital cataract, muscle operations, O'Connor clasp shortening for simple exotropia, simple esotropia, vertical deviations, muscle transplants for external rectus palsy, superior rectus for paralysis of the superior oblique (Jackson's technique), Alastair operation for congenital ptosis, Todd-Mowbray operation for occlusion of nasolacrimal duct (with Drs. Martin and Hosmer).

STANFORD UNIVERSITY SCHOOL OF MEDICINE

Wednesday

FRANK ROBIN. Congenital and hereditary eye defects.
 AVERY HICKS. Ocular torticollis.
 DONALD W. FISHER. Retinal detachment, methods and results.

MOUNT ZION HOSPITAL

Tuesday

HERBERT J. CONY, EDWARD LIPSETT and JOHN SCAFF—9
Tonsil operations, local and general anesthesia, dis-
section, Stader anastomosis

Wednesday—3

HERBERT J. CONY, EDWARD LIPSETT and JOHN SCAFF
Symposium on mastoidectomy
GEORGE S. LACHMAN. Treatment of corneal ulcers
CHARLES WEISS. Recently developed concepts in im-
munology and bacteriology of value to the ophthal-
mologist
FRANK H. ROBIN. Treatment of acute endocyclitis
G. Y. RUSE. Pathological demonstration of various eye
conditions

Thursday

Staff—9. Nasal operations. Submucous resection, electro-
coagulation of turbinates, sinus surgery

Days to be announced

FRANK H. ROBIN and GEORGE S. LACHMAN—9. Eye
operations. Cataract, strabismus, plastic on eyelids

SOUTHERN PACIFIC HOSPITAL

Thursday—2

WILBUR F. SWEET and JOHN C. WILLIAMS. Clinics and
demonstration of cases

CLINICS IN ALAMEDA COUNTY HOSPITALS—WEDNESDAY

PROVIDENCE HOSPITAL

A. J. HOWELL—9. Reconstruction of nose
RODOLPH O'CONNOR—9. Muscle shortening cataract Cur-
ran operation
GEORGE McCLEURE and NELSON KEELER—9. Ear, nose
and throat surgery
RANDOLPH SHARPSTEIN—9. Mottus' operation
ROY NELSON—9. Laryngoscopy and bronchoscopy
BRUCE STEPHENS, JR.—10. Cataract operation
FRANK BAXTER—10. Ear, nose and throat operations
MILTON H. SMITH—10. Ear, nose and throat operations
ALEXANDER GALLBRAITH—10. Ear, nose and throat op-
erations
W. A. MAGRATH—11. Eye operations
ALVIN P. WOLD—11. Eye surgery
F. C. KRACAW—11. Ear, nose and throat surgery

LETTERMAN GENERAL HOSPITAL

Tuesday

A. E. SCHLAUSER and HERBERT H. PRICE—9. Ton-
sillotomies, adenoidectomies, general anesthesia
HARVEY C. MAXWELL—9.30. Eye surgery, general
anesthesia. Strabismus correction by O'Connor
tendon crush and by Jamieson recession

Wednesday

A. E. SCHLAUSER—9. Tonsillotomies, local anesthesia,
nasal operations, local anesthesia

Thursday

HARVEY C. MAXWELL—9. Eye operations, local anesthe-
sia. Cataract extraction, pterygium transplant,
strabismus correction

Friday

A. E. SCHLAUSER, HERBERT H. PRICE and HARVEY C.
MAXWELL—9. Sinus surgery, local anesthesia, extra-
nasal radical frontal ethmoidectomy, radical
maxillary sinusotomy, bronchoscopy, criopharyngoscopy

ST LUKE'S HOSPITAL

Tuesday and Thursday

JOSEPH L. MCCOOL, C. ALLEN DICKIE, A. E. EDGERTON
and CHARLES BATES—9. Ophthalmological clinic

VETERANS ADMINISTRATION

Staff. Bronchoscopic examinations.

R. J. NUTTINO—12. Eye operations
P. T. LEITCHER—12. Ear, nose and throat surgery
FRANCIS SMOOK—12. Ear, nose and throat surgery
SYDNEY N. PARKINSO—12. Treatment of acute and
subacute paranasal sinus infections, lantern slides and
motion picture demonstration

Dry Clinic, 2—4.30 p.m.

Staff. Discussion of operative procedures, demonstration
of cases, lantern and motion picture demonstration

ALAMEDA SANATORIUM

B. M. STEPHENS—11. Cataract

CHILDREN'S HOSPITAL

M. E. LUND—11. Strabismus, operative treatment

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